To my Son,

AN OFFICER OF THE UNITED STATES NAVY, SERVING IN THE FOURTH GENERATION, I DEDICATE THIS LITTLE WORK WITH GREAT AFFECTION.

Acknowledgment.

As I design the following pages to form an elementary treatise on Naval Tactics, and to be used as a text-book, I have, in order to simplify matters, omitted in the body of the work all reference to authorities by name.

I therefore take this means of expressing my great indebtedness to the many writers upon this subject from whose books I have quoted, and whose ideas I have to a greater or less degree appropriated.

WM. BAINBRIDGE-HOFF,
Commander, U. S. Navy.

WASHINGTON, D. C., April, 1894.

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ERRATA.

On page 24, line 18, for "helm hard on towards" read "helm hard over towards."

On page 31, fifth line from bottom, for "foot" read "port."

On page 38, line 21, for "quicker-turning" read "shorter-turning."

On page 38, line 28, for "slower-turning" read "wider-turning."

ELEMENTARY NAVAL TACTICS.

CHAPTER I.

DEFINITION AND GENERAL SCOPE OF NAVAL TACTICS.

I.

NAVAL TACTICS is the art of—

1st. Disposing and installing in ships the weapons used in naval warfare, so that they may inflict the greatest damage upon the enemy, and at the same time preserve to themselves the greatest amount of protection.

2d. Disposing the defensive qualities of ships so as to permit the greatest liberty of movement in regard to their weapons, while protecting in the best manner all these parts necessary to gain this end.

3d. Moving or manœuvring the ship by means of the helm and propelling power, so as to gain some advantage as regards position in respect to the enemy.

4th. Combining and moving ships in respect to each other, or to some natural or artificial obstruction or defence, so as best to employ each and every weapon, while maintaining the greatest amount of support between the vessels.

5th. Moving vessels in force and formed so as to be controlled by general signal.

It is patent from these definitions that the study of naval tactics embraces the planning and construction of the ship, as well as the organization and fighting of fleets.

In the ship, the units of offence are divided among three weapons,—the gun, the ram, and the torpedo; while the units of defence are all embraced in the consideration of armor-distribution; the intimate division of the hull by bulkheads; rafting and water-excluding devices; the celerity of change of direction, and the gathering and losing of way, through rudder and engine power.

There is a certain ratio which must be maintained in a ship, between her offensive and defensive qualities. No weapon mnst be so placed that it cannot be employed at its full value, through the insufficiency of its defence. For instance, a gun capable of doing certain work against an enemy's armor must be put behind a protection sufficiently strong to enable it to be brought acceptably into action.

The ship will have to defend herself against three classes of weapons which attack the hull at different depths:

A. Obstructions or Mines, which operate against the bottom, between the turns of bilge.

B. Rams and Torpedoes, which act against the side between the turn of bilge and a line below the water-line.

C. Shells and Shot, which assault the ship above this line.

No gun or torpedo can be made so powerful that it can stop short in her career a ship laid on to ram the vessel firing at her. Hence the ram is the weapon to be most dreaded. Fortunately it is the weapon most difficult to use.

Ram-blows given, or ram-blows received, are best absorbed

by distributing the strength and thickness of the hull over the whole fabric. The blow of a ram is comparable to the striking of an object with an axe. To be serviceable, the axe must have its weight distributed over the external figure, and not concentrated at some point remote from its cutting edge. It must resemble A, and not B. (See Plate 1, Fig. 1.)

It is of vital moment to protect in the best manner possible the ship's engines and boilers, rudder and connections. A ship in action that cannot move is doomed to destruction, no matter how powerful she may be.

However, no defence can be made strong enough to shut out the heaviest assaults of offensive weapons. Therefore the constructor must strive to gain for his hull as slow sinking conditions as he can, and endeavor also to have his ship sink on an even keel in the event of disaster incident to extensive penetration.

The precision of gun-fire depends in a great degree upon the steadiness of the platform, and upon the large slow-firing guns being installed as near as possible to the pivoting-point of the vessel, so as to be free from the aberration in pointing due to the traverse of the ship, which would be the case if the guns were placed at the extreme ends. This applies especially to stern fire.

The use of the ram depends upon the ability of a ship to turn quickly, and to change with the greatest promptness her rate of speed and her direction—either ahead or astern—through the water.

The torpedo is the weapon which finds its greatest sphere of usefulness when installed in heavy-armored ships endowed with modest speed, to offset their inferior turning qualities and slowness; and also when fitted to the lightest

vessels of small size possessed of enormous speed, which are intended for the sole purpose of destroying the heaviest ships at great risk to themselves, and with the chance of only dealing a single blow.

II.

For these reasons, and to serve best the ends for which it was built, every vessel must be surveyed in a tactical sense. As the human body, although symmetrical to outward appearances, has, as far back as we can reason, been developed on lines seemingly opposed to this symmetry—so it is with the ship. For instance, man has developed right-handedness; probably because his most vital organ is situated on his left side; so that, by advancing his right side and employing his right hand more dexterously, he affords better protection to his heart.

To apply this reasoning to the ship, it will be found that she changes direction better with one helm than with the other; that there are certain qualities of the screws which make her turn more favorably towards one particular side, or which cause her to gather or lose speed more quickly under certain conditions not at first apparent. There will be, too, some common bearing where her guns will unite in doing most execution, where their supply of ammunition will be the most easily kept up, and where their crews will be best protected. Taking the ranges of the guns into account, there will be some particular distance at which you will have the enemy at the greatest disadvantage. Then as to her torpedo outfit. It will be decided which installation is to be used with the greatest facility, and against an attack from what

quarter will it be most effective. Also what rate of speed can be attained without interfering with the precision of fire with this weapon.

When we have discussed in order every factor of the offence, then a consideration of the defensive qualities is in order. On what bearing does her armor, or protection of coal, or bulkhead arrangement best cover her vitals, this important steam-pipe or outboard connection, or that ammunition-supply? And so on through every question entering into the fighting of the ship.

Out of this all, by drawing comparisons between advantages, and disadvantages comes a settlement upon *three* things:

1st. Some presentation of the ship, which shall be the strongest to offer to the enemy for offence and defence.

2d. Some rate of speed, which shall serve your weapons best.

3d. Some one range for your guns at which the greatest damage will be inflicted.

Doing all this is making a tactical survey of your ship; and upon this bearing, with this speed, and at this distance you must endeavor to keep and fight your enemy.

Further on we will see that what is true of one ship is true of ships in combination; and that, in solving the problem concerning the position to be occupied by ships in the line of battle, the question of rank of the several commanding officers hardly even enters.

CHAPTER II.

WAR-VESSELS.

I.

To be able to meet the enemy, we must oppose him with a fleet equal, at least, to his own in numbers, construction, speed, and offensive power. To protect our coast, we must be supplied with proper vessels which can keep the sea, yet be of sufficiently light draught to enter most of our harbors. They must be either very swift, or else adequately defended against the fire of the enemy's ships which they are likely to encounter, and must also possess weapons of the very best pattern.

To assist these fleets, we need protected vessels of large size-termed cruisers; also a smaller class of the same name; corvettes and gun-vessels.

Torpedo-vessels of good size—in fact, torpedo-cruisers,—able to keep the sea, armed with automobile torpedoes and machine-guns, are most necessary, but are not of the line of battle.

Torpedo craft to act in smooth water, armed with automobile torpedoes, must be provided in large numbers.

Each war-vessel should possess as many as possible of the following qualities:

1st. Good speed, with a reserve speed immediately available.

2d. Resistance to sinking; great water-discharging capacity.

3d. Quick turning; great helm power.

4th. Strong ram bow; ability to ram in its class.

5th. Heavy bow fire, looking to the greatest penetration for the largest, most destructive missile that the fighting of its particular class and size of enemy will demand.

6th. Broadside and stern fire of as many and as large quick-firing guns as she can carry.

7th. Fair weight of secondary battery.

8th. Ability to use all weapons under all conditions of the sea.

The foremost factor for war: the ideal unit of the line of battle is the battle-ship. She should have, in addition to the qualities mentioned above:

1st. Armor-resistance to the penetration of large shells. (This weight of armor to call for a sacrifice of coal- and stores-carrying capacity.)

2d. A merging of the number of broadside guns into an increased weight of gun, designed to augment the strength of stern fire.

3d. A complete all-around installation of the heaviest automobile torpedoes.

4th. Largest possible secondary battery.

Since the battle-ship has not the speed of the large cruiser, herself adequately protected against a fairly heavy class of gun-fire, she must offset her inferiority of speed by being able to keep the cruiser from ramming her, by means of her torpedoes; and stand off the torpedo-cruiser, and her smaller congeners, by the fire from her secondary battery.

The cruisers of both classes must have:

1st. Armor-resistance to quite a heavy class of gun-fire.

2d. Great speed; great reserve force for speed.

3d. Broadside installation for automobile torpedoes.

4th. Greatest coal- and stowage-capacity.

5th. Non-fouling protection for the bottom.

6th. Largest secondary battery.

7th. Ability to berth and transport large crews.

The reason for bow or stern installation of the automobile torpedo is not apparent. If the ship is laid on for using a torpedo ahead, she is in a position for ramming; and it would be wiser for her to go ahead at the great speed she is capable of making, and ram her opponent, rather than to use a weapon of less precision and probably less effective, and which, under the circumstances, might affect or damage the firer. Again, in running away from a ship in chase, using a stern installation, and firing a torpedo through the disturbance created by two or three screws turning at their fastest speed. would be less effective than the using of some of the older devices of strewing the wake with floating torpedoes.

As a large cruiser has a large tactical diameter, a complete installation of torpedoes in broadside will be most effective. To protect herself from torpedo craft, the ability to maintain a heavy fire from her secondary battery is most vital.

The corvette should be roomy and fast, have a large coal-capacity, be of strong scantling, and be sheathed with copper. She should be capable of making good speed under sail, and be suitably sparred and square-rigged. She may be built of steel, or constructed in a composite manner. She should have no fitted torpedo installations.

Ships other than those protected by armor should be constructed to shut out secondary fire from entering their

primary battery, and their secondary battery should in like manner be defended from machine-gun fire.

The larger the ship, and the more feeble her protection against gun-fire, the greater must be her speed and her coal-endurance. Such a vessel is of less value to the line of battle, but she may be needed for other duty quite as necessary, such as commerce-destroying, or carrying or convoying an expeditionary force to some strategic centre.

The exterior of ships must be smooth, so that a scraping past of the enemy, which might possibly occur, would not demolish sponsons and disable guns.

The conning-turret, wherever fitted, must be protected from as heavy fire as the ship would be called upon to stand. It must be roomy, have the most approved means of communicating with the different parts of the ship, and be easy of access and exit.

The armored tops must be so designed that they do not become death-traps. Fire from aloft is most advantageous; and marksmen, to do their work well, must feel measurably safe.

Cruisers and corvettes are not only the eyes of the fleet, but they become commerce-destroyers, convoy-ships, and defenders of temporary bases.

The gun-vessel of any class, and the torpedo-vessel of any size or peculiar designation, belong with the fleet, and may be utilized for supply, and dispatch-vessels. Gun-vessels should be fitted with bow torpedo-tubes. Torpedo-vessels should carry machine-guns, and the smaller ones spar-torpedo fittings.

Torpedo-nets are generally furnished to line-of-battle ships; they will probably keep out all but the largest class of automobile torpedoes.

II.

All ships must be *fighting ships*. Although it may be said that unarmored vessels should not engage armored ships or fortifications, still it will probably happen that unarmored men-of-war will have to do just that very thing, and therefore we should strive to have our ships as good "all-around" ships as their inches will permit them to be.

CHAPTER III.

THE SHIP.

I.

FORMERLY, when the ship was put in commission, the captain, officers, and men could go to their posts, recognize everything within their jurisdiction and care, and be up with the requirements of their stations. Nowadays, so far from this being the case, the joining of the ship means for each one the taking up, in his special department, some novel application of science or some new mechanical device, studying it and mastering it.

For the captain, it means the constant oversight of his subordinates to determine whether the results they give him in their special departments are adequate and good. He must supply the vital strength, nerve-power, and necessary intelligence, which shall circulate throughout the whole mass of his command; give it life, and infuse energy to make it fulfil in the most laudable manner the earnest of all those things for which it was assembled as a fighting unit.

What one of the oldest naval fathers said of his time applies perfectly to the captain of to-day:

"Absolute force amounts to nothing if one is not able to compete in capacity with another which knows how to crystallize and control the elements of such force. The ship which

attacks another is sure to triumph if the one attacked does not know how to fight or is not able to do so."

Being endowed with the necessary nerve, the captain must come to his command with a fundamental knowledge of naval drill and a complete mastery of the methods of signalling. With this equipment he is fitted to begin his research into the most intimate and intricate understanding of the individuality of his own ship, and, in a general sense, the knowledge of the requirements of his consorts.

Signalling has passed out of the phase of a looking into the signal-books at the last moment, with a general condemnation of the compilation at not finding what you want, because you do not know how to look for it. Formerly, there was plenty of time to learn at the minute, and correct mistakes before the execution of the signal. Now we have only seconds to work in, and no chance to correct errors. Therefore the modern captain must not be willing to let his fertile brain fail to carry out its ideas because he is ignorant of the methods by which he can transmit them beyond the range of his voice. When this point is reached, he must know *himself*, by all methods of signalling, how the communication must be kept up, and must employ as little as possible any intermediary. By this means time is saved and time wasted means inevitable disaster for the ship.

II.

The manœuvring qualities of a ship lie in the application of the forces supplied by her helm and her engines, acting though the rudder and propellers. The screw is the present general means of propulsion applied to vessels; and where sail-

power is not furnished, the screws are two or more in number. By means of these the ship is given speed ahead or astern, or having acquired momentum in either direction, a reversal of the screws is used to absorb this force and bring the vessel to a standstill. During any time that the ship is moving in the water, a movement of the rudder will cause a change in the direction of the ship's head.

A ship moving at a high rate of speed through the water carries along with her a body of water called the *water envelope*, which is being constantly made on the forward edge near the bow, and which is constantly losing the exact weight of this accretion of water off the after edge, some distance astern. This causes the ship to swim, as it were, in a tank of fluid which she takes along with her. The phenomena entering into the water envelope are quite complex and elaborate in their nature and discussion, but only those parts concern us which govern the ship's movement under the influence of her helm and engines.

The rudder power is at all times active, owing to the constant passage of the water particles on each side of the rudder. It is, however, very different with the engine power, which is slow to act, owing to the screws working in a complex condition of currents created by the screws themselves and the passage of the bulk of the ship through the water. For this reason, although the screws will be turning in a reverse way, their effort to absorb the momentum is not at first apparent ; and the screws do not get out of the influence of the water envelope until the ship has advanced more than *twice* her length, and do not operate in good water, and produce a state of rest for the ship, much before she has advanced *four* times her length. Indeed with very large ships, this condition

does not come about until the vessel has gone ahead *five* or *six* times her length, which fact becomes a very important one when taken in connection with naval tactics. We will see shortly that the time and distance occupied by a vessel proceeding at great speed will, on reversing her engines at their best power even, advance for four lengths at very nearly the same speed, and nearly cover the same distance, that she would have done if she had kept her engines going steadily ahead.

So far as the consideration of helm enters into the question of ramming or avoiding collision, it is all embraced in the first six points of turn of the ship's head on either side of the straight. This governs the extent of what is known as the ship's *manœuvring area.*

To define it more closely, the manœuvring area is that area or sea which a ship must pass over to avoid collision, either by use of the helm or speed, or both, with the engines going ahead or reversed. Referring to Plate I. Fig. 2, we have the positions of a large ship, steaming at the speed of twelve knots, plotted every five consecutive seconds, taken when steaming ahead on the straight, and with her helm hard over in each direction. At *A* her speed is still twelve knots: at *B* and *C* she has changed the direction of her head six points, with the speed reduced to 9.5 knots by the effort of turning, and she has *advanced* from *O*, 3.5 lengths, and traversed to the side, or *transferred*, nearly two lengths. Now then, mark the side boundaries and the boundary to the front, which govern her movements during the time necessary for her to avoid a collision or ram an enemy. If we take intermediate helm-angles for the same elapsed times, we will have on each side of *A* a series of points; and if we trace a line through them, as *B A C* (see Pl. I. Fig. 3), we will inscribe an area which we

call the manœuvring area. This description refers to the area occupied by the ship when going ahead.

For a fact, should the ship, when going ahead at twelve knots speed, suddenly reverse her engines in order to stop her way as soon as possible, or should put her helm hard over to either side, as in the former case, her manœurving area would resemble very nearly, in all its measurements, the manœuvring area for going ahead; and if we place this manœuvring area exactly over the other, as we have done in the figure referred to (see Pl. I. Fig. 3), we will be surprised to see how little difference it makes, as regards the position of the ship during this time, whether we continue to go ahead with the screws, or whether we go astern with them. Looking at the figure, we see we arrive at A' in the same time that we arrive at the point A in the first case, and that these points are very near each other. At A' we are, however, dead in the water. The same thing is to be observed in the positions B' and C': both are near B and C, corresponding positions in the "going ahead" diagram. At B' and C', however, the ship is stopped.

It will be noticed that these diagrams show that the quickest way to stop the advance of the ship is to reverse the engines and heave the helm hard over.

The narrow portion of the manœuvring area—D (same plate and figure)—is called the *neck.*

Corollary to all this showing of the quickest method of stopping the advance of the ship, it may perhaps occur that the fitting of *twin rudders*, to the stern-post might be serviceable, each rudder to be hung on an edge of the stern-post (see Pl. II. Fig. 1), and be capable, through their being independent of each other, of swinging out on their own sides, and so act as a *water-brake.*

Theoretically there would be no *transfer*, and their use should prevent the *advance* of the ship at least one-third from what it would be without using the helm and only reversing the engines. The strain and weight would be very much increased on the stern-post by these twin rudders; but it would seem that their fitting was not beyond what mechanical skill could supply. Again, in case one rudder was disabled, you would have a spare one immediately available.

III.

The following explanations and definitions relate to the manœuvres of the ship:

Change of course; change of head; change of direction.—Bringing the ship's head on some compass point other than the one previously occupied.

Movement or *manœuvre.*—Making a turn, or less than a turn. A component part of an evolution.

Evolution.—The movement or movements by which a ship proceeds from one position to another to gain some tactical advantage.

Transfer.—Sea gained towards the side or flank in turning.

Advance.—Sea gained towards the front in turning.

NOTE. *The advance is the ordinate, and the transfer the abscissa, of the curve at any point.*

Octant.—That part of the turn included in a change of head of four points.

Quadrant.—That part of the turn included in a change of head of eight points.

Final Diameter.—The diameter of the final circle, when

all the forces controlling a ship's movement have assumed a fixed relation to one another.

Tactical Diameter.—The distance between the position of a vessel heading in one direction, *when she commences to turn*, and her position when she has turned and is heading in an opposite direction.

Front.—The direction in which the ship heads, except when she is *obliquing.*

Right Flank.—Sea to the right of the ship.

Left Flank.—Sea to the left of the ship.

Rear.—Sea astern of the ship.

Oblique (see Pl. II. Fig. 2 A).—A change of course of three (3) points; used to gain sea to the right or left; employed to diminish or increase the distance between ships in line (see Fleet definitions) where the front is unchanged.

Half Turn (see Pl. II. Fig. 2 B).—A change of course of four (4) points; used to gain sea towards a flank, and so change the front four points.

Turn (see Pl. II. Fig. 2 C).—A change of course of eight (8) points. Used for moving towards either flank, or to charge front eight points.

About (see Pl. II. Fig. 2 D).—A change of course of sixteen (16) points. Used to change front to rear.

Circle (see Pl. II. Fig. 2 E).—A continuous turning through thirty-two (32) points under the influence of either helm.

Figure of Eight (see Pl. II. Fig 3).—Performed by moving through sixteen (16) points with either helm, then quickly throwing the helm hard over in the other direction, making a complete turn of thirty-two (32) points, and finally, by reversing the helm again, make a complete circle in the other direction,

and so on. The movements are to be continuous. Used to present alternate sides of your vessel to the enemy firing at you from a fixed point.

IV.

The reason that a ship, in turning, does not describe a circle is due to the fact that when the helm is put over she is moving in a straight line, which her momentum seeks to continue. It is only by degrees that she yields to the power of the rudder, and then she is always an observable time behind it. The quicker the helm can be put over, the quicker will the vessel respond, and also more rapidly will the diameter of the turning-circle decrease, and the time, if the helm angle can be decreased to 40° or more. We must have great angular movements for rudders and their connections, and quick-acting power immediately available to move the helm.

The radius of the turning-circle of an ordinarily large vessel is about 300 yards, with a speed of twelve knots on the straight, and a helm angle of about 30°.

Some qualities of the turning-circle bear more on naval tactics than do others; for instance, the *advance* and *transfer* for the first six points of turn are of the highest importance, as we have seen. The determination of the *tactical diametcr* is also imperative.

The *loss of speed* in turning through a whole circle may be assumed at three times the length of the vessel.

A vessel with two screws, if she goes ahead on one and backs on the other, describes a spiral which constantly diminishes until its diameter becomes nothing, when its motion of translation ceases. If this vessel went ahead on one screw

and stopped the other, she would describe a turn of less diameter than if she went ahead on both screws and used her helm hard over.

The curve which a ship with a single screw makes in turning has generally been set down as a circle, and when the helm is righted she is supposed to start off on a tangent to this circle. As we have before stated, this is not so. Although the assumption may answer for the ordinary purposes of fleet drill, it would prove wofully inaccurate in fighting with the ram.

V.

The methods in practice for plotting the turning-circle are generally very crude. The following method, however, has been found to answer very well, and furnishes a good rule to work by where the ship is of good length. The question of length enters, because you measure from a base-line on board ship; and the shorter the base-line, the greater chance there is for errors to creep into your work.

Choose a calm, still day in the open sea, but in view of a distant point of land or object sufficiently conspicuous for observation. Prepare two casks with flags or staffs, each flag to be of a different color. Care must be taken to weight the casks, so that a very few inches remain above the water: this in order to prevent wind-drift, an element calculated to mar the accuracy of the experiment. Range-finders, or plane-tables equipped as range-finders, are used to take cross-bearings from the ship on one or the other of the buoys. In case you have to fit the instruments yourself, they are to be placed, one forward and one aft, on the side *towards* which the turn is to be

made. These sighting-instruments are to be put the same distance from the fore-and-aft middle line of the ship; the distance between them to be as great as the length of the ship will allow. All angles observed will be reckoned from a *zero point*, which is right abeam. The distance between the sighting-instruments is the base-line of the triangle. The graduated ring of the standard compass, and the alidade mounted thereon, will be used for observing the distant point of land. Four observers are necessary: one to note the successive bearings of the distant point, and change of direction of the ship's head for every four points; one to note the times; and one at each alidade to note the angles between the perpendicular to the base-line, and the bearing of the buoy about which the ship is turning.

All being in readiness, the two buoys are to be dropped about 1500 yards apart, on a bearing convenient for observing the distant object at each point in the turn around either of them. A hand is stationed to sound the engine-room gong, and another hand is stationed at the steam-whistle. The engineers are ordered to note the engine-counter at each sound of the gong, and the man at the whistle is directed to sound it at the orders, "Stand by!" and "Stop!"—the gong to the engine-room being struck at the order "Stop!"

The ship is now put on a course nearly parallel to the line of the buoys, and at the speed desired. (See Pl. III. Fig. 1.) One buoy is passed in this manner; but when the second buoy comes about four points on the bow, the observer, noting the time, gives the words, "Stand by!" and "Stop!" The whistle sounds for each, and, at the second, the helm is moved to the determined angle, the observer at the compass notes the

the position of the ship's head both by the compass and the bearing of the distant point of land, and the engineers note the engine-counter, while the observers at the bow and stern note the bearing of the buoy. As the ship arrives at four, eight, twelve, and sixteen points change of course, the observer at the compass in like manner gives the words, "Stand-by!" and "Stop!"—when the whistle sounds, and the time, bearings, angles, and revolutions are taken.

When a series of observations completing the turn of sixteen points is thus taken, the ship proceeds on a course nearly parallel to the line of buoys, and a turn of sixteen points is made around the other buoy, either at the same speed and helm angle, or with any desired variations of either or both. The experiment may, of course, be varied by stopping or reversing one or both engines in a vessel with twin screws, at any point in the turn; and in all cases the exact position of the ship, when she has turned through four, eight, twelve, and sixteen points, respectively, can be laid down from the observations.

The plan will be understood from Plate III. Fig. 2, which represents an actual complete experiment. Here the ship has arrived at a straight course at the point P, then going 5 to $5\frac{1}{2}$ knots with thirty-five revolutions. At this moment the helm is ordered 34° a-port; the angles *abh* and *bah* are observed, the engine-counter noted, and the time taken. At d^1 the ship has turned, by compass and bearing, four points. At d^2 she has turned eight points, and so on, and at each position the observations are repeated, the experiment being complete when the middle point of the ship is at d^4. The respective positions can easily be laid down to scale by a protractor with sufficient accuracy for practical purposes. The object of hav-

ing two buoys is to save time, and to allow the ship to recover herself on a straight course before repeating the experiment.

VI.

We now take up the analysis of a single turning-experiment, to see what principles govern it.

Plate III. Fig. 2, shows the trace of the curve made by a vessel in turning. The curve is drawn differently from what has been usual in the first part of the turn. When the trace is assumed to be that of the centre of gravity, near the middle point of the ship, it has been usual to show the arc it describes at the beginning of the turn as tangential to the original course. There are, however, good reasons for believing that the curve described is more truly represented in the figure. It is certain that the stern of the vessel does not describe a curve to which the original course is a tangent, and of this we will be given one conclusive proof. If two ships are steaming in column in smooth water, and the order is given to alter course in succession,—say to starboard,—the sternmost ship will see that the foremast of the headmost ship does not alter its bearing for some time after the stern has swung to port, and the wake of the leading ship will have a bend in it to port, which becomes an excellent mark for the sternmost ship to go by for putting over her own helm when she comes to this point. It is called the "kick." (See Pl. III. Fig. 3.)

In most heavy ships this *kick* amounts to a sagging of the whole vessel to such an extent to the right or left of its course (according as the helm is put hard-a-starboard or hard-a-port), that the vessel transfers a distance, at least equal to its beam, to the side indicated, and does not gain a position clear

of her former course until she has advanced two or more ship's lengths from the spot at which her helm was put over, when she has in addition changed the direction of her head fully three points.

The reason for this is that the resistance of the water-pressure on the bow turned *from* is not able to offset the combined forces acting at the time on the ship,—the momentum tending to *advance* her, and the rudder power tending to *transfer* her stern to the side towards which her helm is moved. It is only after these forces have balanced themselves that the ship continues her course on the curve in obedience to her helm.

VII.

The turning-circle made by two screws acting on the ship is comparable to the action of the single screw: that is, if each screw is turning at the same speed in the same direction. When, however, there is a difference in the speeds where one screw is stopped, or where one screw is reversed, the change in the relations of the different parts of the turning-circle becomes very great, except during the first octant. By referring to Pl. 4, Fig. 1, we can see at a glance the effects produced by the screws acting under different relations to each other. There are three curves to compare.

Category No. 1. Where both engines are going ahead at the same speed.

Category No. 2. Where the starboard engine is stopped, the port engine going ahead at the same speed as in No. 1.

Category No. 3. Where the starboard engine is reversed, while the port engine is going ahead, both engines making the same number of turns as in No. 1.

In every case the helm is hard over (34°) to port, and the effect of the wind is not considered.

It will be noticed :

First. If we wanted to avoid a collision in the first octant, the manipulations of the engines would assist us very little, as the position of the ship is very nearly the same for all three curves.

Secondly. We can save an advance of *one-fifth* of the greatest advance made, when the vessel has turned through the first eight points, if we turn under Category No. 3 rather than under No. 1. It may be remarked too, that this is the *greatest amount of advance that can be saved in turning.*

Thirdly. When the position of the ship's head is reversed, the advance is substantially the same for each of the three categories. One point, however, merits the closest attention : turning under Category No. 2, you turn through sixteen points in the shortest time. That is, *with one engine going ahead, and the other engine stopped, with your helm hard over towards the moving engine, you reverse the ship's head in the fastest time possible.*

Now where does the advantage lie in turning for the twin-screw vessel? We see at a glance that it is in the *transfer*, and that Category No. 2 has the advantage over Category No. 1 in saving *one-third* of this distance ; while Category No. 3 saves *one-half* of the amount of sea, when compared with that traversed when turning under Category No. 1.

There is a great deal to be learned from the study of this figure ; especially when the manœuvring of vessels formed and in force may make collision between them other than a remote contingency.

The two things which oppose a ship's turning when the

helm is put down, the ship steaming ahead, are *inertia* and *water-resistance*. They are remarkably different in effects, inasmuch as inertia, as an opposing element, is at its *maximum* when motion *begins*, and when water-resistance is at its *minimum*. Then, as we go on applying the accelerating force of rudder-power, or other force which has a moment about the pivoting-point of the ship, we generate angular momentum, and then water-resistance. When we have once started the ship, so that every point in the middle line begins to revolve around the pivoting-point, we get momentum of all the particles in the ship around this point. There are, in fact, moments of momentum set up by the first action of the rudder, which are added to the moment of rudder-power and increase as the angular velocity increases. But a check to this growing angular velocity is developed by the increasing resistance of the water. Then we have, tending to turn the ship round on the pivoting-point, moments of momentum and moments of rudder-power, which are opposed by moments of water-resistance. It is evident that ultimately moments of monemtum must be equal to moments of water-resistance, and that there will remain the constant force of the moments of rudder-power opposed also by equal moments of water-resistance, leaving no unbalanced forces, and so giving a uniform angular velocity to the middle fore-and-aft line of the ship, and she turns in a circle. This circle is spoken of as the *final circle*.

By absolute experiment it has been determined that the first quadrant of the circle is passed through in the quickest time, although the distance traversed is greater than in any subsequent quadrant. Until the final circle is entered upon, these three phenomena present themselves for every succes-

sive quadrant: less speed, shorter paths to traverse, and a longer time to perform that part of the turn.

When the motion of rotation has become uniform, and the centre of gravity is moving in a circle, the keel-line of the ship makes a *constant angle* with the tangent to the circular path of the centre of gravity. Pl. IV, Fig. 2, illustrates this case. A represents the bow and B the stern of the ship; G shows the position of the centre of gravity on the keel-line AB; O is the centre of the circular paths in which G, A, and B are moving; TGT is the tangent to the path (GG_1G_2) of the centre of gravity; and the angle ($D'GT_1$) made by the keel-line with the tangent is termed the "drift-angle."

This drift-angle amounts to nearly one point at a speed of twelve knots.

A rough measurement can be made of the drift-angle, by observing the angle made by a light line, one end of which has a drag attached to it and trailed in the water, while the other end is made fast to the cathead on that side towards which the turn is made.

In regard to the *heeling* which accompanies turning, and which bears most especially upon the question of gun-fire, it may be said that the forces which tend to produce it are as follows (see Pl. IV, Fig. 3):

1. The centrifugal force acting outwards through the centre of gravity of the ship, and tending to make her heel away from the centre of the circle (R).

2. The lateral component of the rudder-pressure, acting through the centre of pressure of the rudder at some depth below the centre of gravity of the ship, and tending to make her heel inwards towards the centre of the circle (Q).

3. The lateral component of the fluid-resistance on the

outer side of the ship, which equals in magnitude the resultant of the centrifugal force and the rudder-pressure, and acts through the centre of lateral resistance (P).

Vessels with high speed and quick-acting helm-control have the heaviest heeling-angle. In some cases a heel of 6° has been observed.

It has been determined that the angle of heel varies—

(1) Directly as the *square of the speed* of the ship;

(2) Inversely with the *metacentric height;*

(3) Inversely with the radius of the turning-circle.

VIII.

There are three classes of tables which must be made out for the ship and corrected constantly.

The Helm Table.—A study of the effect on the movement of the ship of the different helm-angles. The influence of the wind on turning. The advance and transfer for the different octants, under different speeds, with the engines turning with different relations to each other.

The Speed Table.—A study of the effect of the screws on the movement of the ship with respect to gathering and losing way. The factor of wind-power.

The Tactical Table.—A digest of all the phenomena of the turning-circle. A study of the effect of trim, and of foulness of the bottom, on the ship in regard to her speed and turning power. Different draughts of water. The whole question of fuel supply and consumption. Taking on of coals, etc.

From the instant that the pennant is broken at the mast-head when the ship is commissioned, until the time that she

passes into the hands of the dockyard authorities, these tables can never become too complete.

It will be hard, too, to overestimate their value to a new commanding officer on the occasion of the recommissioning of the ship.

CHAPTER IV.

THE SHIP IN ACTION.

I.

ALTHOUGH gun-fire is no longer the only power of attack, still the fight will undoubtedly be opened by artillery, and its conduct will be principally based upon its use. The ultimate design, however, will be to ram. The whole point to strive for will be a commanding position,—a position of advantage,—using the guns to reduce the enemy to a condition much below the normal, and then to use the ram or torpedo to deal the *coup de grâce.* We refer more especially to combats between single ships, but the remarks apply as well to fights between numbers.

Discussing the subject of single combats, it is a fundamental principle that a ship need never be rammed by a slower one ; indeed, if the turning-powers are equal, the faster ship can always ram her antagonist. While this remark is strictly true, it is necessary to look a little into the meaning of the terms "faster ship," "slower ship;" how near can the speeds of the two vessels become alike, and yet have the principle hold?

Where the tactical diameter of one ship is only half the length of the tactical diameter of another ship, and where the shorter-turning ship requires three minutes to reverse her

course, with a speed of eight knots on the straight, the vessel with the larger turning-circle, to perform the same manœuvre, must steam at the rate of ten knots on the straight. Therefore it is well to put down, in an engagement between two ships, where their turning powers are equal as to time but unequal as to space, that the *faster* vessel should possess twenty per cent excess of speed to feel sure of her power to use the ram.

Speed, then, is so valuable a quality that it may be said to cut down the number of the slower vessel's weapons from three to two. Therefore, the slower the vessel, the heavier must be the defence, and especially the protection against ramming.

Speed for *entering* action is most necessary. Where you are deficient in heavy rapid-firing guns this quality is certainly of vital importance. There are cases, though, where slow speed will be used ; as, for instance, two vessels running side by side : each would naturally tend to slow and turn toward her adversary, as neither could advisedly permit the other to enter her wake close astern.

If you are stronger in gun-fire than your adversary, smokeless powder will assist you greatly.

As a rule the enemy should be put in a position to leeward of the attacking ship, so that the smoke from the guns and funnels combined will blind him. It follows as a postulate, that should a vessel unfortunately be placed in this position, before closing with the enemy, befogged with smoke, she should stop firing, so as not to add to her difficulties. It may be observed, however, that some of the best tacticians do not see in this leewardly position all the disadvantages charged against it.

A vessel in action with another will find that her opponent will possess one of the following combinations of qualities—

1st. Greater speed, larger turning-circle;

2d. Greater speed, smaller turning-circle;

3d. Less speed, larger turning-circle;

4th. Less speed, smaller turning-circle.

Each of these categories will call for different action on the part of the ship to secure a position of advantage in respect to the enemy, or to suffer as little as possible from the manœuvres of her adversary.

II.

The tactical value of an offensive weapon, *at any instant* during an engagement, may be completely defined by stating—

1st. The area within which it can strike;

2d. The chance that it will strike any desired point;

3d. The damage that it will do.

The area within which the ram must strike at *any one instant* is a point situated on the prow of the ship. The area belonging to the gun, within which it must strike, is measured by the sector of fire of the gun, where the radius of the circle described to define its limits is 1500 yards in length—assuming this distance as the extreme range at which single combats will be fought. In regard to the torpedo, the area under consideration, within which the weapon must strike, is comprised within its sector of train, drawn about its port, with a radius representing the range of the torpedo—say 350 yards. The lines of fire that can be drawn within these areas are, for the gun and torpedo, as a matter of course infinite in number.

To classify, then, the areas within which these weapons

can strike in respect to their extent, we have the following order:

1st. Gun;

2d. Torpedo;

3d. Ram.

In regard to their striking the desired point (i.e., their accuracy), they probably stand—

1st. Ram;

2d. Gun;

3d. Torpedo.

In respect to the damage they would do, the order would be—

1st. Ram;

2d. Torpedo;

3d. Gun.

If, however, we consider the tactical value of the weapon through *any interval of time*, the foregoing simple classification will not hold. The values of the weapons are largely enhanced or diminished by the time element, so that the question becomes very complex, and varied almost to infinity. As we know, the element of time enters largely in connection with the handling of the ram, in a smaller degree with the torpedo, and hardly at all in the case of the gun.

III.

History shows that but few vessels in modern times have been put out of action by other than gun-fire.

The increase in the speed of ships, and the rapidity with which they will have to move in future fights, oblige us to look to every means to increase the quickness of fire, so that

we may hit the enemy as many times as possible in a given time. The engagement will probably be so short, sharp, and decisive that there should be no limit to this quickness, save when the smoke interferes with the pointing.

Gun-fire is of two kinds: the slow and heavy guns to fire against the enemy's material; the rapid-firing and light guns to destroy the enemy's men. But this lighter, secondary battery, is in its fire sufficiently strong to interfere very effectively with the service of the enemy's principal ordnance, and his torpedo offence, by its playing upon their points of installation. Heavy secondary fire is very available also for damaging the screws and rudder of the enemy. The large guns, the principal battery of the ship, must only be used where there is a chance to produce a serious effect, while the machine-guns and small arms must search out the small openings in the conning-tower, sighting-hoods, shields, and ports, and demoralize the protected people.

Secondary fire should be opened on the enemy as soon as possible. It can begin, for the 6-pounders, at a distance of about 3000 yards, and for the larger calibres of the secondary battery at about 2000 yards. Machine-gun fire of small calibres and small-arm fire are available at 1500 yards. The great-gun fire of the ship has its greatest weight inside of 1200 yards.

The precision of fire depends on—

1. Relative movements of the two ships;

2. The smoke from the guns and funnels of your own and the enemy's ships;

3. The pitching and rolling of the ship firing;

4. The uncertainty of the intervening distance;

5. The action of the wind;

6. The state of the nerves of the firer, from his knowing that the instant he discharges his battery the enemy will do the same.

The speed at which ships on opposite courses approach each other must be such that when passing at short distances the chance of being hit by the enemy's shot or torpedo is reduced to a minimum, through the shortness of time that his weapons will be effective. Then when the enemy has passed by you need the greatest speed to get out of the range of his most aggressive fire, to turn quickly and get back at him, or to strive to enter his turning-circle, where you will be safe from any possibility of his ramming you.

It may be said that in passing so rapidly this way each ship loses her opportunity of using her gun-fire on the other. This is so in a degree, but you are rather *forced* to keep up the speed. You have probably discharged your heaviest artillery before you have reached your antagonist, and you would hardly dare, at this point, to stop your engines in order to prolong the period of your presumed superior artillery-fire, lest he, noticing the slacking up in your speed, should instantly take advantage of his then superiority in this respect, and give you his ram, which, with your way falling off, you could not manœuvre to avoid. In point of fact, to reduce your way you would have to stop your engines some lengths before coming up with his bow, otherwise the momentum of your ship would make your speed quite as great, when you passed your antagonist, as if you had not touched your engines.

Since an engagement between two vessels is very likely to degenerate into an artillery duel, each moving in the same direction around the circumference of a common circle, each

vessel should look out for torpedoes dropped in the wake by the other.

Unless you are going to run away, keep your stern as little as possible towards your enemy; and if you are circling in an artillery duel, keep if possible by your speed, the enemy bearing a little forward of your beam. The instant he begins to grow abaft your beam, it shows that he has the heels of you, and if he continues his advantage of speed, will get in your wake and eventually ram you. You must immediately throw him out of his advantage by ceasing to circle, or by circling in the other direction: you can turn with greater or less advantage to yourself by applying the rules given further on for ramming.

Firing the guns of the principal battery by electricity, in an action between ships from some central point of control, is of doubtful utility; but gun-fire by individual act should be so tied down by hard-and-fast rules, that the battery-officer could only exercise his own judgment within strictly defined limits.

With regard to torpedoes, their discharge should, in action between ships, be directly under the control of the conning-tower.

The rudder should be made use of very sparingly in sighting guns.

IV.

Undoubtedly the ram is the most terrible weapon furnished the ship, but it is the hardest one to handle, since it depends upon being able to calculate for a vessel of thousands of tons weight, her position to within one hundred feet, when moving in a seaway at a speed of perhaps fifteen knots, with

no point of rest for the eye of the captain for judging, except the bearing and heading of the other ship moving arbitrarily at an equal speed with his own.

In regard to vessels entering a combat, by rushing immediately at each other to strike *head on*, it would present itself to the mind in two phases of opinion. If you feel that you are safest meeting the enemy by presenting to him your bow, the strongest part of your structure, the novelty of the position, or the fear of a successful ramming on his part, would most likely lead you to keep your head on him. But as you approach your opponent, smoke may obscure him for a moment, or he may waver; and if he wavers, you will hardly be able to judge of that "half of a ship's length," which makes your ramming attack either a success or a disaster; and so, through caution on your part, you change your mind in regard to keeping your bows on his, and you and the enemy will turn from each other, on the safe side of automobile-torpedo range; use your artillery; charge past each other; and as you pass mutually establish a point of departure, after which it will remain with you to apply the proper tactical rules to maintain your advantage over the enemy.

Much more unlikely than ramming between ships upon first encountering each other is scraping alongside.

The ramming attack will only take place when one vessel has the advantage of position to do it, and will never take place when the opponents are on absolutely equal terms. Each vessel will strive to enter the turning-circle of the other, and when this advantage is gained by one ship, the other one will manœuvre to overcome it by throwing her enemy out of her turning-circle; and so gun-fire and torpedoes will be used, until a moment will come when the vessel that has lost the most

in an artillery sense will try to even up matters by ramming her antagonist. The ram then remains the weapon of last resort, always provided the manœuvring qualities of the ship are intact.

If yours is the ship which is being put at a disadvantage as regards guns, and we will also say torpedoes, and you wish to ram your enemy, then as soon as you conclude that you have attained a commanding position you must commence work. Should you try and fail, then make up your mind to strive to remain alongside and foul of your antagonist, for this position will be the safer one for you, as regards your demoralized guns and torpedoes. The enemy cannot use his torpedoes, as their explosion would be as likely to injure him as to damage you. Again, the contingency of capturing him by boarding is not to be entirely ignored. Small arms and machine-guns are thoroughly effective alongside, and their use might establish a condition of affairs that would prevent him from serving his guns, and so bring you up to an equality with him—enable you to clear yourself from him, and ram him again—this time, we we will say, with better results.

Before contact is made with the enemy the engines must be stopped.

As far as ramming duels are concerned, the following theorems and the rules under them cover nearly all the cases of manœuvring, and should be committed to memory and put in practise, so that proper movement of the helm would become almost automatic, when you are acquainted with the manœuvring qualities of your opponent. These rules are not infallible, but they contain the consensus of opinion of tacticians as to the best thing to do.

(*The faster vessel has twenty per cent excess of speed.*)

THEOREM I. Where the speeds are different, but the turning-circles equal in diameter, the faster vessel can always ram the slower.

Rule 1. The vessel having the greater speed should strive to turn with the helm the same way as her antagonist. (See Plate V, Figs. 1 and 2.)

A with greater speed than *B* completes her own circle and enters *B*'s.

Rule 2. The slower vessel must strive to constantly throw the enemy out of its turning-circle by turning from him. It can be done with least advantage when he has the enemy heading for him, and with the greatest advantage when the enemy has his broadside towards him. (See Plate V, Figs. 3 and 4.)

In Fig. 3, *B* turns from *A* to delay ramming, with *least* advantage; and in Fig. 4, *B* does the same thing, with *greatest* advantage.

THEOREM II. Where the speeds are equal, and the tactical diameters different, the ship with the smaller diameter should never be rammed.

Rule 1. The shorter-turning vessel should strive to turn with her helm opposite to that of her antagonist. (See Plate VI, Figs. 1 and 2.)

No matter whether A turns under B's stern or away from her, B using her helm opposite to A will enter or remain in A's circle. Where A turns away from B, B should not turn beyond the third octant, *B*′.

Rule 2. The wider-turning ship should endeavor to turn with her helm the same way as her enemy, and delay his getting a position of advantage.

THEOREM III. The vessel with the greater speed has the advantage of the vessel with the smaller tactical diameter.

Rule 1. The quicker-turning ship should strive to turn as close to the enemy as possible.

Rule 2. The speedier vessel can delay her turn and offset the helm advantage of her antagonist.

In Pl. VI, Fig. 3, B gains all he can by a quick turn, while A, the faster vessel, stands on and makes his turning-circle beyond the point where B's speed will permit him to arrive and enter it.

As a *postulate* to *Theorem I*, it may be stated that the swifter vessel, if astern within limits, has the advantage. The slower ship should make it a stern-chase, while the faster ship, keeping after her, but out of her wake, should endeavor to draw up on her quarter and ram her.

Another *postulate* to the same theorem is that the swifter vessel, if ahead, can always make it a ramming fight, for she can gain at any time enough sea to turn and face her opponent.

It is now in order to take a look at the field of battle itself, and see why certain points of it constitute areas of greater danger than do others.

What is a position of advantage for the one ship is naturally a position of disadvantage for the other, and a discussion of the question is an examination into the relative bearings of the two ships, their distance apart, the angular distance of their courses, and the controllable conditions of their speeds.

We consider two vessels, A and B, of equal tactical value, and it is to be shown that one of them can, to a greater or lesser degree, force the other to assume a disadvantageous position, and that this locality may be termed the "danger-

field." To escape from this environment requires certain tactics which, if not adopted, put the threatened vessel in a constantly increasing position of danger, until she arrives at a point called the "position of greatest danger," where her destruction is imminent. (See Plate VI, Fig. 4.)

A is in this position as regards B: If A attempts to turn in order to put himself on equal terms with B, B will ram him. A can only use a weak stern-fire on B. B can keep up a powerful bow-fire on A. A has perhaps one advantage over B—he can use his torpedoes better.

The *danger-field* is the forward half of A's turning-circle on either side if A and B bear relatively as in the diagram. In order that A shall clear the danger-field and meet B on equal terms, the time that it takes him to turn through the first two quadrants must be less than the time it would take for B to get to him. The necessary distance can be determined by A measuring B's mast-head angle.

A can hardly escape when, having swung through, say, the first quadrant, he runs off at right angles to his first course, for his pursuer having only to move on the circumference of a larger circle has had his speed but little reduced, and therefore arrives in A's wake nearer to him than on the last course. In other words, unless A can shake B off by superior speed, he only *helps* him by turning. (See Plate VII, Fig. 1.)

In a ramming duel, then, one vessel will try to force the other into the danger-field, and to the position of greatest danger in that field; and the question arises how to avoid it for one, and how to force it on the other. If two vessels are manœuvring, and one is unable to approach the other, the one has the advantage if he can get in the wake of the other within 400 yards. The pursued is, of course, safe as long as

he steers a direct course, but if he attempts to manœuvre, he shortens the distance between himself and the pursuer. By the pursued having the advantage, is meant that the natural impulse of the pursued is to fight, and the instant he turns he comes in the danger-field. (See Plate VII, Fig. 2.)

There is another phase of this example: Suppose A wishes to close with B. If he can force B into his wake at a distance that would take B a longer time to traverse than it would for A to turn his bow to B, then A could effect his object, or if B continued to stand on and not turn towards A, then A would have B in her danger-field. (See Plate VII, Fig. 3.)

In all ramming attacks, it may be said that the great object to strive for is to arrive at a *safety point* inside your enemy's turning-circle, and it follows as a maxim that the ship which passes first into the turning-circle of the other has achieved a great advantage. It may be further said that this advantage is as easy to lose as it is hard to gain, through a misjudging of your adversary's capabilities. When you gain this advantage use it instantly and for its full value!

V.

A discussion of the use of bow torpedoes from a fixed installation in the cutwater or in the keel-line is but discussing the question of ramming, and all the rules which apply to the one apply to the other.

In case the torpedo is installed astern the best time to use it is when the vessel, having missed ramming you, passes under your stern. Or should two vessels be passing on opposite courses, B turns across A's stern. A would stop and fire his torpedo with his head pointing in such a direction that it

will reach B at B'. (See Plate VIII, Fig. 1.) Then shifting his helm in the same direction as B, he starts ahead at full speed and continues his circle. There is really no good reason why he should continue to turn beyond *a*, unless he has much greater speed than B, as any further turn brings A within B's turning-circle and puts him at a disadvantage as regards B.

Should the torpedo be installed in the side, the instant of discharge will depend upon the speed of the two ships. It is of great importance to discharge your torpedo so as to strike your adversary before he can fire his concentrated broadside. The exact place of installation is really of great moment, especially for distances close aboard. Probably the best in broadside is as far aft as possible, as the great point is to have a torpedo ready to prevent the enemy ramming you, which he will try to do on the quarter. The discharging-tube should admit of a train three points forward of the beam.

As an example of when the broadside installation is of greatest use, we suppose two vessels to steer courses that intersect; the slower one can use his torpedoes on the faster at any time that the ships are within 350 yards of each other. In this case, also, the best point of installation would be as far aft as possible, as the slower vessel could always turn from the faster vessel and have him in range as regards his torpedo. (See Plate VIII, Fig. 2.)

VI.

Two Ships Engaging One (*the one more powerful than either of the other two*).

a. If the two ships are equal tactically, in order to use their artillery power to the best advantage they should ap-

proach the single ship so that their batteries would present the most guns through the longest time.

b. But should their combination for offence be such that one has better ram-power and the other greater gun-power, then they must form so as to give each ship the best chance to use her most effective weapon.

In either category, however, these two ships must act together to obtain satisfactory results.

To fulfil the conditions of the first combination, they should approach their enemy so as to offset his superiority by their greater *handiness.* This would consist in their entering the enemy's turning-circle a number of times, only to be thrown out each time by his perhaps superior speed, or through their being *obliged* to take up a position at longer range, owing to the great weight of fire of his large guns. The fight on the part of the consorts in dealing with one larger ship would be to prevent being separated, and thus be whipped in detail, and this can only be avoided by sedulously striving to keep inside of her turning-circle.

They should approach the one in column, that is, one ahead of the other, and near together. The sternmost vessel in approaching with her consort the one ship should keep a little on the quarter of her leader, on the side of the wake nearest the enemy, until just before passing the enemy, when the sternmost vessel should sheer to the other side of the leader's wake. In this way most guns are unmasked for the longest time. It is better to approach in column than in line (that is, abreast each other), as the larger, stronger single ship might attempt to run between the two and give each one a much stronger fire than they could return; or again, if they were in line, when they wanted to use their most effective fire in pass-

ing, one vessel would interfere with the fire of the other. Being in column, however, the single vessel would be deterred from dashing at the leader, to ram him on the onset, since the sternmost vessel would be in position to certainly ram him—the single vessel.

The larger enemy, in fact, will not let the smaller vessels approach him nearer than 500 yards, because they have two torpedoes to use where he can use only one. The two on passing their enemy should round to under his stern, enter his turning-circle, and hang on his quarter as long as they can. In this position they will be in line or something resembling it, and being head on to him will present the smallest target. Although this position admits of their being *raked*, it gives them the chance of using their heaviest guns on his weakest portion; and then, too, they *must* head up for him, and strive to keep in his turning-circle, if they wish to fight at all! The fight, then, for the two, as far as formation is concerned, consists in receiving him in column, and after he has charged past, in rounding to under his stern and following him up, re-forming in column when the single vessel turns again for the new encounter.

The tactics of the single ship is to use up the two with gun-fire; to charge between them, and separate one out, and try to get him on the run; or to bring them both on a bearing, and so get one of the two to interfere with the fire of the other.

To fulfil the category where one of the two has great ram-power, she should take the place of the sternmost ship in the column, and essay to ram the single ship on the first onset. She can do this, since she has her leader for a point of rest for the eye, to "sight" her position in respect to the enemy. If she fails in her first rush, she should proceed with her consort

to use their artillery as laid down in the case just considered, being then formed in line, and then afterwards await the second encounter formed in column, ready to try conclusions with the ram on the next charge past.

If it should happen that the three vessels engaged were of about the same size and were equal tactically, then the two could do best by keeping one on each quarter of the single ship so that an angle of 90° was subtended by their cross-fire. They should be near enough to the one to prevent her taking on a sheer to turn and ram either one of the two.

The one ship, so hardly beset, should try and draw off gradually to one side, concentrate her fire on the ship nearest to her, and trust to the smoke to drop down astern, where she would be better off, and where she *might* achieve a position which would permit her to use her ram upon one of her assailants.

VII.

Two Ships against Two.

The advantage lies with the two ships which keep closest together, formed either in line or column. The point to strive for is to get the vessels separated and steering divergent courses, and then combine two on one. Here a complete understanding between the two vessels on either side in regard to helm and speed signals will tend to a solution of the action in their favor. For in no engagement will the speed be so varied, or the helm be so much used, as where two ships are pitted against two.

VIII.

Three Ships against Two.

The general rule is for each side to strive and ram the enemy's ships farthest off. The two ships, keeping well together, should try and ram the two ships farthest off the line. Other than this rule there is no special tactics for the two ships to use. The great point is to use both of your ships on one of the enemy, if you can.

For the three ships, a formation is best where two of the ships are in line, and the third ship is kept in the rear, ready to assist either of her consorts which may be attacked.

CHAPTER V.

THE SEA ARMY.

THE ORGANIZATION AND COMMAND OF THE FLEET.

I.

THE commander-in-chief of a fleet in time of war has from the outset a very complex duty to perform, viewed from a tactical standpoint. Not only must he be able to exercise his fleet in the various evolutions, and to classify and to arrange his ships in line of battle according to their values as regards speed, armament, and turning qualities, but he must know just what types of vessels are suited to compose his squadrons, in order that he may undertake the work cut out for him.

Although the word *Fleet* is employed to designate the fighting force under the command of an admiral, it does not begin to indicate the number of vessels under his control. Indeed there are so many vessels not of the line of battle, that, when compared with the fighting units, the tactical problem which presents itself in regard to the protection of these non-combatant associates of the fleet seems harder of solution than how to fight the enemy.

This array of ships, even in its simplest aggregation,—that which has to do with encountering the enemy on the open sea,—consists not only of ships which go to make up the line of battle, but other fighting ships, as squadrons of small cruisers,

corvettes, gun-vessels, and torpedo-vessels. Then there is a non-combatant list — ammunition-supply ships, coal-supply ships, and torpedo-dépôt ships. These supply-vessels are specially built to accompany the fleet, and are different from the cargo-carrying merchant-steamers and steam-colliers. All these non-combatant ships must be kept in touch at all times with the line of battle.

The enemy's fleet has, of course, the same *impedimenta* to care for, but this does not make the tactics of the engagement less complex; for not only must you protect your own supply-vessels, but you must do your best to cripple the enemy by capturing or sinking his.

In case the admiral is called upon to establish the blockade of a coast, or command an expedition against an enemy's port, then the number of ships outgrows enormously the ordinary conception of a *fleet*. Bases must be established, with very many ships for replenishing the combatants with stores, ammunition, and coal, and these cargo-carriers must be convoyed and protected by small cruisers and corvettes.

Among the factors which enter into the establishment of the fleet may be cited, supply-ships of various kinds, store-ships, commissariat-ships, floating workshops, countermining flotillas, hospital ships, tugs, cable-laying and telegraph ships, ordnance and coal vessels.

To express the scope and size of this aggregation of vessels the term *Sea Army* seems very appropriately applied.

The questions governing the organization of such a sea army do not come within the consideration of an elementary work, but the preceding remarks concerning it should impress the student with some idea of the tactical problem to be solved, viz., the interdependence for supply and protection

existing between the fighting units and the silent consorts which must accompany them.

II.

In regard to the ships composing the line of battle, they must be so much alike as to be able to act together against the enemy in any tactical evolution which the admiral may require to be performed.

The line of battle will be composed of armored ships of the greatest size and power, and of protected and partially protected cruisers.

If these ships differ very widely in type and speed, a tactical survey should be made of all the ships of the force, so that they may be arranged to have the weak points of any ship in the formation strengthened by the protection to be afforded by her consorts ; and, further, so to assemble the force for battle that the formation may be broken up into smaller portions, where each part shall become eminent for certain qualities, as speed, handiness, ramming, fire ahead, broadside fire, and so forth.

Again, very clumsy and slow vessels had better be taken out of the line of battle altogether, and associated with a force which might be held in reserve. The idea of a *reserve* is not that of a force which enters the arena of battle after the fighting line has encountered the enemy, but has reference more especially to the assemblage of ships not of normal quality; for this so-called reserve should contain rams, gun-vessels, and torpedo-cruisers, which must act independently of the main force, but be manœuvred on some prearranged plan in which their peculiar qualities are best developed.

A fair definition of the term *reserve* would be, that part of the fleet which contains factors that would interfere with the efficiency of the fighting line if employed with it, and which also contains factors that would have their special qualities much impaired if assembled in the main formation.

The protected or partially protected cruisers are thoroughly adequate to be classed with line-of-battle ships as fighting consorts; but the advantage of their superior speed, which in any line of battle must be kept down to that of the slowest ship, must not be thrown away. Therefore cruisers in the fighting line must be put in some part of the formation from which they can be withdrawn without breaking up the formation of the remainder of the line of battle—this in case that these cruisers should be needed for any emergency; as, for instance, to strengthen some hardly-assailed point, or to concentrate quickly upon some weak point in the enemy's formation.

Squadrons of smaller cruisers and corvettes are useful for employment as "vedettes"—to be the "eyes of the fleet"—when cruising at sea. They should stretch over a distance of twenty miles ahead, and ten miles in every other direction.

This vedette or lookout squadron is a regularly organized body, and differs entirely from single ships sent out from the main force to feel the enemy. These last may be termed "skirmishers."

There are other vessels which are fighting units, hovering between the reserve and convoy portion of the fleet and waiting on the line of battle. These are despatch-vessels, gun-vessels, and torpedo-vessels.

In the *convoy* we have special types of vessels; among them vessels fitted to carry ammunition. As they will have to sup-

ply the fleet under all conditions of environment, their fittings, as regards protection from the projectiles of the enemy, defence from any attack, and ability to supply their cargo, becomes a serious war problem. The armament of the ammunition-ship should be a large number of machine-guns. The enemy will do their utmost to capture or destroy such a vessel.

What is true of the ammunition-supply ship is also true of the coal-supply vessel, which is a ship regularly built for the purpose, and armed with machine-guns.

Among the special ships is the torpedo-dépôt ship. This vessel must be capable of getting torpedo-boats of quite a large size in and out of the water, and be able to carry quite a number of them. She must be capable of making *great speed*, so that in case the state of the sea will not permit of her torpedo craft being used she can keep out of the enemy's reach.

III.

For the combatant portion of the fleet what kinds and numbers of ships are adequate for service to engage the enemy on the high seas? Probably the smallest number to establish an efficient fighting line would be—

4 large line-of-battle ships;

4 small line-of-battle ships (sea-going monitors and turreted vessels);

4 large protected or partially-protected cruisers;

16 torpedo-vessels of large size.

(These torpedo-vessels are not part of the formation, but keep at all times with the line of battle.)

In the *reserve* we would have—

4 armored vessels or rams (ships whose peculiarities render them unfit to be put in the line of battle);

4 torpedo-cruisers;

4 despatch-vessels;

4 gun-vessels.

All these vessels, except the torpedo-cruisers, should be furnished with a good outfit for towing vessels.

The vedette squadron would contain—

4 cruisers of great speed, perhaps feebly protected;

4 small cruisers;

8 corvettes.

The vedette squadron during an engagement will keep an eye on and protect the vessels composing the convoy.

The *convoy* portion of the fleet embraces—

1 torpedo-dépôt ship, carrying from 4 to 8 torpedo-boats;

2 ordnance and ammunition supply ships;

2 (or more) coal-supply ships.

The line of battle under ordinary circumstances of manœuvring would have associated with it the *armored* vessels of the reserve; but in time of action the reserve would break up into its indicated units, so that the ships would be free to use their most eminent weapons in the most independent manner.

In respect to operating on an enemy's coast or against a port, the combatant elements become so special that it is impossible to state exactly how they should be grouped, or what ships would constitute the groups.

IV.

Vessels will certainly be obliged under some circumstances to coal at sea, but the problem regarding their supply seems no nearer a solution than it did ten years ago. It is true that

great speed enables vessels to go into sheltered harbors, coal, and not be a long time absent from the theatre of action; but so much more coal is used than formerly, that if we can go farther for it, we have to go more frequently.

The strategic value of coaling-points is apparent. Nations with navies must make sure in time of peace that their vessels will not be rendered useless in time of war through a lack of fuel-supply. This supply may be divided into two classes: *fixed*, or coal stations; and *movable*, or by steamers using a temporary base. Probably the carrying on of a war will require both systems to be in a degree maintained. Each has its advantages, but undoubtedly the last category presents the greatest number.

To insure a coal-supply under the last category, in time of peace, the Government must encourage a large proportion of the fast merchant-steamers to be so built that they can carry cargoes of this commodity to such rendezvous as the nature of the war shall decide. These rendezvous, from a strategic point of view, should be as varied as possible in location, so as to mislead the enemy. The advantages of a movable coal-supply here become apparent. The location of the depots not being known to the enemy, the capture of the supply-vessels is much less likely. Then, the points of supply being near the base of operations, little or no coal will be consumed uselessly. The drawbacks to this method of supply are: that a rendezvous where the fleet could coal, having a hostile environment, would be harder to establish, and, if established, would be more likely to be attacked in force. Then, again, steamers at the outbreak of a war may be hard to obtain, the distances that they have to be sent may be very great, and the fleet might suffer in consequence.

V.

A good means of communication between the admiral and his ships is vitally important, as the success of an action depends upon this thing.

The admiral for this reason must have an intimate acquaintance with the signal-books, and in them should be laid down his general plans of battle, and the lines of action that will be followed in an engagement. These plans, in common with all other tactical manœuvres, should be thoroughly discovered to his captains.

Too great stress cannot be laid upon the necessity of the captains being thoroughly cognizant of the admiral's plans, in order that they may render an intelligent obedience to them. If the commanding officers of the ships are not imbued with the spirit of the commander-in-chief, have not his confidence, and are not conversant with his tactical plans, then only disaster and defeat can be looked for.

In order to have signals read, formations should be simple and compact, and coal and gunpowder must be of a smokeless variety. It is the general opinion that signal-flags can best be seen from to windward.

The admiral must be in possession of all the tactical qualities of the ships of his fleet, and he must see that his captains know all these things for their own ships, and those with which they are associated. In like manner, too, he will establish tables of masthead angles and speed, and helm coefficients for his ships, which shall enable them to maintain their positions in the formation and insure their carrying on of evolutions in a safe and seamanlike manner.

Should the admiral seek an engagement with the enemy, he should endeavor—

1. To surprise and attack him when he is unprepared;

2. To throw the whole of his force upon a part of the force of his antagonist.

There are, however, certain points upon which the admiral will wish to be informed, and feel certain in regard to, before a collision with the enemy is brought about. They are:

Are the nearest coast ports friendly, neutral, or inimical?

What are their distances, and how do they bear?

Can reinforcements be depended upon during the action?

In what direction can it be reasonably hoped that these reinforcements will appear?

It may be set down as a maxim, that if a fleet, in *any* formation, discovers the enemy near at hand,—as, for instance, through the lighting up of a fog or coming around a point of land,—and this enemy in the midst of performing an evolution, it is the duty of the commander-in-chief of the formed fleet to charge the other, even if the formation then in is not a good one for attack, and the formation the manœuvring fleet is striving for is better than his own.

VI.

The post of the admiral in action is something of great moment. The admiral must be able at all times to withdraw himself from a position where he is not seen. He must be able to get to a position where he is most needed. He must at all times be well protected!

This condition of affairs cannot be met by embarking him in his heaviest and most formidable ship of the line, because

such a ship is not endowed with the fastest speed. Then, again, when the admiral considers it expedient to proceed from one part of the field of battle to another, he might take such a vessel away from a position where she was most needed, a hot corner where she was doing good work, to a comparatively unengaged portion of the line.

The only ship fulfilling all the tactical requirements of a flag-ship, which has great speed and good resisting qualities, is to be found in the best and fastest protected cruiser that he can possess.

He and his war staff should be protected by a roomy and very strong conning-turret, beneath which is the captain's conning-turret, so arranged that communication can be adequately kept up with the admiral.

The admiral's post should have no telegraphs or speaking-tubes; his communication concerning the manœuvres of the ship can be through the captain alone.

Over the admiral's turret, and surrounding the signal-mast, will be the strong shield which surrounds the signal-staff. The admiral, through the grating-deck over his head, can communicate directly with the signal-officer immediately above him.

The admiral under these circumstances is embarked in a ship which is sufficiently strong and well enough protected to enter as hot a fire, for a limited time, as he need encounter. He may not necessarily lead into action, and his flag-ship is not the best ship to destroy the enemy by gun-fire. His complete understanding, however, with the commanding officers of his armored ships will safely permit him to delegate to them the privilege of leading the way into action.

CHAPTER VI.

THE FLEET UNDER DRILL.

I.

Definitions.

Alignment.—A prescribed dress either to the right, left, or centre, or on a particular ship. The ship dressed or aligned upon is termed the *Guide.* Alignment has reference also to the keeping of one vessel astern of another next ahead.

Distance is the space between ships on the same line of bearing, measuring from the nearest point of the water-lines.

Evolution.—The necessary movement or combination of movements by which a force of ships, acting together, proceed from one formation to another.

Movement or *Manœuvre.*—Action of the whole force or any detached portion of it. A component part of an evolution.

Conversion.—A method of changing front in line through not more than *four* points; performed by the vessels steaming a course normal to the line bisecting the angle of change of front, at varying speeds (those vessels on that side towards which the turn is made going slowest), until the line of bearing is at right angles to the new front, when the force comes together into line on the new course. (See Plate IX, Fig. 1.)

Direct Movement (sometimes termed an oblique movement).—Made by a ship passing from her station in one formation to her station in some other, by the nearest route, observing the rules of the road. (See Plate IX, Fig. 2.)

Isodromic Movement or Evolution.—Vessels in line change front eight points (to either flank) by the vessels all steaming ahead at the same rate—except the ship farthest off from the flank changed to, which turns and heads for the new front, running astern of the force, and takes her new position: when she passes astern of the next vessel to her, that vessel turns and steers for the new front; and so on, until the whole force has changed front to the flank indicated. This inverts the order of the formation. (See Plate IX, Fig. 3.)

Simultaneous Movement.—Each vessel of the force changes course at the same time from a common course, through the same angle, to some other course. In practice that vessel towards which the change is made, first marks the manœuvre. (See Plate IX, Fig. 4.)

Successive Movement (rectangular movement, counter-march).—Changing direction, when in column, by following in the wake of the leader, which has turned through a given arc. If the change is for eight points, the movement is *rectangular;* if the change is sixteen points, the movement is a *counter-march.* (See Plate X, Fig. 1.)

Wheel.—A manœuvre performed by *two* vessels in line through four, eight, or sixteen points, turning either to the right or left flank. The inner ship uses a speed which permits her to turn through the designated number of points in the same time as the outer flank ship, turning on a larger tactical circle. (See Plate X, Fig. 2.)

Formation.—Any arrangement or combination of vessels

on a line of bearing, or on lines of bearing, designed for cruising, attacking, retreating, or anchoring.

Line.—Ships on a line of bearing at right angles to the front. (See Plate X, Fig. 3.)

Double Line.—Ships on two parallel lines of bearing at right angles to the front, the ships in one line being astern of the ships in the other. (See Plate XI, Fig. 1.)

Column.—Ships on a line of bearing in the direction of the front. (See Plate X, Fig. 4.)

Double Column.—Ships in two parallel columns, the leaders abreast of each other. (See Plate XI, Fig. 2.)

Échelon.—Ships on a line of bearing which makes an angle of 45° with the front. A bow and quarter line. (See Plate X, Fig. 5.)

Double Échelon.—Ships on two lines of bearing from a central ship, each line making a bow and quarter line with this middle vessel. In double échelon, when the vessels head in direction of the point, they are said to be in "chase formation," and when the vessels head away from the point they are said to be in "retreat formation." (See Plate XI, Figs. 3 and 4.)

Column of Sections.—Ships in column with section front in line. (See Plate XII, Fig. 1.)

Groups.—A formation in a triangle or square, but generally triangular, either equilateral, rectangular, or scalene. The ships occupy, in any case, the angles of the figure. (See Plate XII, Figs. 2, 3, and 4.)

Naval Square.—A formation of equal front and depth. The ships are so disposed that distances and intervals are equal, and the same in number. (See Plate XII, Fig. 5.)

Interval is the perpendicular distance between the lines

of bearing when the force is in some compound formation. It is also the shortest distance between two formations.

Simple Formation.—Ships in formation arranged on one line of bearing.

Compound or Complex Formation.—Ships formed on more than one line of bearing.

Indented or Alternate Formation.—A compound formation, where the ships are arranged as shown in Plate XIII, Figs. 1 and 2.

Order.—The numerical arrangement of the force when in some formation. If the vessel leads in column, or is on the right when in line and is *number one*, the order is said to be *natural.* If this number one is placed on the left of the line or is the rear vessel of the column, then the order is said to be *inverted.*

Line of Bearing.—An imaginary straight line passing through the same point in each ship of a formed force. It is expressed either by its magnetic direction and called the *Absolute Bearing*, or is expressed in terms of the ship—as two points abaft the beam—and called the *Relative Bearing.*

Battle Front.—The bearing of the enemy.

Table of Distances.

Half distance	=	1 cable	=	200	yards.
Distance	=	2 cables	=	400	"
Double distance	=	4 "	=	800	"
One mile	=	10 "	=	2000	"

II.

Formations.

There are tactical precepts which are common to armies fighting on shore and to fleets engaging at sea. Napoleon says: "Concentrate your forces; do not have a weak point. To move *en masse* and with rapidity on the enemy, and to attack him where he is weakest, is the secret of victory."

The principle which answers to this is *concentration.* This precept of war, which is universally admitted to be excellent, is especially applicable to fighting with rams. To weaken or to destroy by greater numbers a part of the enemy's fleet, then to be able to bear down afresh on some other part of his formation with a superior force, is the special object of all attacking manœuvres.

A fleet is formed for battle when all the vessels composing it can use perfectly all the means of offence and defence that they are provided with, without interfering with one another or detracting from their mutual support. The offensive weapons of the line of battle are guns, rams, and torpedoes.

Formations are useful for purposes of cruising and anchoring as well as for fighting. Fighting formations are of two kinds—those used for attacking, and those used for retreating. At least the requirements for separate formations to meet these two conditions of battle are demanded by *some* tacticians; but it must be said that most of the favorite formations of a few years ago, whose geometrical beauties were so striking to the eye, and whose strength was so apparent, are dis-

appearing under the exactions of greater speed in ships, and the employment of improved weapons.

Although the formation of the force of to-day is simple in its structure, *formation* and *strict arrangement* are more vital than ever before, since weapons as regards hitting are used within much narrower limits than formerly, which their greater precision enables them to be, and vessels out of position will interfere materially with the free use of their consorts' guns, rams, and torpedoes. The good and efficient drill of the fleet in its simple formations must make up for any want of power that the mathematical arrangement of some complex formation might possess, but which has to be discarded, lest certain virtues of the modern ship be lost.

In regard to all battle formations, it may be said that simplicity must rule. The more simple a formation is, the harder it is for the enemy to break it up, and in case it is broken up, the easier it is to regain. When a formation is so large and so elaborate as to require most of the attention of the captain to preserve it, instead of his putting his mind on thrashing the enemy, it has no value for fighting, and should disappear from the category of a battle formation.

It is, however, in order to meet certain cases that some of the formations which are in a manner *archaic* should come under discussion in these pages.

The principal conditions which a formation of a fleet for attack should fulfil are:

1st. The largest amount of liberty of evolution for each vessel, and at the same time the best employment of the peculiar fittings of each ship for attack.

2d. It should permit the execution of every manœuvre in the least time, with the greatest speed.

3d. It should be simple, flexible, and easy to keep, under all conditions of sea and weather, without exposing the ships to collision.

4th. Unity of direction of each vessel's course must be preserved. The vessels must maintain their stations, and they must be able to change rapidly to the direction of the enemy's attack.

5th. It should be such as to permit the fleet to be able to cope with any particular necessity for preservation imposed on them by the enemy.

6th. Between vessels of the fleet there must be mutual support, either for attack or defence.

7th. It should permit the fleet to be kept well together under the eye of the admiral, so that each vessel can see his signals.

In dividing the fleet, should the basis of division be either the group or section, attention should be paid to the equality of the ships which are to act together, more especially to their manœuvring capabilities. These vessels should exercise together, should learn to move as one, and should only be changed under circumstances of necessity.

Since 1872 the idea has been gaining ground that the *unit* of organization is the section of two ships. These vessels are always next to each other in the formation, and as a result of comparing the tactical surveys of the ships of the force, are picked out to join forces for offence and defence, since by this means more power for war is got out of the two than would be the case where each acted singly. This power for war may be spoken of as applying the principle of concentration. One vessel of the section is termed the "Leader," and its consort the "Mate."

Fighting formations all come within one of the four following categories :

1. Narrow front—great depth ;
2. Extended front—slight depth ;
3. Front and depth equal;
4. Groups.

The first category is represented by column ; the second, by line, chase, and retreat formations ; the third, by the square ; and the fourth, by every formation that may be included in the group system.

Formations may be either natural or inverted, according as the order is *natural* or *inverted.* The natural order should always be maintained except when forced by circumstances to form in an inverted formation, which should be only as temporary as possible.

It is the opinion of tacticians that it is easier to maintain *close* rather than *open distance* for general manœuvring ; and since it is conceived to be safer to keep close to one another in a fog, close distance will obtain in battle. What constitutes "close distance," as ships get larger and heavier, will depend on a thorough knowledge and a close scrutiny of their *manœuvring areas.*

The intervals between ships in two lines should not be less than six cables for a speed of ten knots. This would permit the second line to engage the enemy two minutes after the first, if the enemy's speed was equal and his course opposite in direction to the formation in two lines.

It may be set down as a maxim, that the victory will probably lie with that fleet whose formation will permit it to keep its integrity the longest time.

It is patent that the smaller and the simpler the formation

is the greater is the chance of its being kept together; but, again, if you divide up your force into a great number of small parts you increase the number of flanks exposed to the enemy's attack, where he can combine or effect a concentration. Granting this to be a fact, it does not, however, seem to apply to small or auxilary formations, properly disposed for mutual protection, and acting in concert in obedience to some prearranged plan. In this case each and every exposed flank is covered by a small formation of a portion of the force ready to concentrate on the enemy if *he* attempts concentration. Take four ships, for instance, formed in line, and cover either exposed flank by four other ships also formed in line, or formed in column, and placed some distance to the rear. Here are eight ships of a force with *four* flanks exposed, but the enemy certainly has no greater chance to concentrate on any flank than if there were eight ships in simple line or simple column, when there would be only *two* flanks exposed, for the other small formation is immediately ready to offset any advantage gained by the enemy. Indeed the two formations have greater facilities for frustrating his designs, as they are in a much more flexible combination, and it is harder to break in upon their arrangement.

III.

A formation in line is brought forward as a formation especially favorable for the use of the ram, as it presents that weapon at all times to the enemy.

It is claimed, however, that it possesses several disadvantages, which are as follows:

1st. It is hard to preserve the dress of the vessels.

2d. It is so extended as to favor concentrated attacks of the enemy anywhere on the line.

3d. The admiral's signals will be hard to make out by vessels on the flank.

4th. The flanks are unprotected.

5th. It is a bad formation for broadside fire.

6th. It is not flexible; changes of direction require long and difficult manœuvres.

7th. It is the easiest formation to break through and break up.

Notwithstanding this formidable array of charges against it, it has many champions, who say that the whole force is brought up to the enemy at the same moment, and that as you turn to come back to the attack your broadside guns are thoroughly effective, as you are substantially in column when you make the simultaneous movement of coming around.

Vessels in line should be at least the width of their manœuvring areas apart; this gives them the unobstructed use of their rams.

Line as an attacking formation is unwieldy when bearing down upon the enemy, as the enemy will draw to one side or the other to threaten your flank. If you preserve the absolute bearing of your line and merely change the courses of your ships simultaneously to head off the enemy, you will probably enter the fight formed in more or less of a bow and quarter line.

Double line, although not properly a good cruising formation, is an excellent formation for advancing in when feeling the enemy. It is probably the most imposing of all of them in appearance, and seems the hardest to assail, as no formation seems quite adequate to handle it. It is, however, not

dangerous to the enemy, as regards either gun-fire or ramming, as so many of the broadsides of the ships are covered by those of their consorts.

IV.

The bad points charged against the formation in line apply equally to formations *in échelon*, either single or double. Although a formation *in échelon* presents to the enemy a line of rams and a line of fire, yet it is a dangerously bad formation if attacked in the direction of its line of bearing, as it is not flexible. An angular formation, such as a chase formation, permits the use of only one broadside on the enemy; moreover, it is a hard formation to maintain, and an attack from rams is liable to get it into confusion. Although a formation in chase-angle gained for the Austrians the battle of Lissa, its disadvantage is in changing direction. The point of the angle must be kept towards the enemy, otherwise the enemy will concentrate on one of the flanks. Owing to its unhandiness as a general formation for attack, it is not to be recommended. In fact the most modern tacticians condemn it entirely as too clumsy. Unless the enemy, in some simple formation, were very badly managed, he would be able to turn in such a way that he could always avoid the point, and thereby flank the fleet.

The retreat formation, as a formation for retreat or otherwise, has few friends, and may be considered obsolete. Any spread-out formation such as this is bad. For retreating, the best formation is perhaps in columns, with the least injured ships nearest the enemy. Authors who recommend spread-out formations to serve this purpose forget the following con-

siderations:—A spread-out order supposes that all the vessels can steam without assistance, and are still in a condition to fight. This hypothesis is not tenable, for a fleet would retreat fighting, and only after a reverse or failure. On its face a spread-out order permits an enemy with superior speed to concentrate its force on some point of the fleet in retreat, and destroy it.

In regard to any *échelon* formation, it may be said that the opportunities for using the broadside battery are most excellent; but there really is little mutual protection afforded from ramming, and the formation is hard to keep in, and harder to get out of into any other, *preserving the same battle front.*

With high-powered guns the *range* of one vessel's fire nearest the enemy need hardly be considered as more effective, when compared with that of some other ship in the same formation a little farther off; so that there would be accounted no greater force of gun-fire from six vessels arranged in a bow and quarter line, than there would be from two formations in column of three ships each, arranged as shown in Plate XIII, Fig. 3, where the lightly shaded ships show the *échelon*, and the darker ships the formation in columns. There can be no question of the superiority of the two columns over the formation in single *échelon* as far as *flexibility* is concerned!

V.

Before we consider the subject of formation in *groups*, let us look at the formation in *naval square*. It is attractive because it is compact, signals are easily read by all the ships, and there are no manœuvres needed to gain sea in any direc-

tion save change of course. It is, however, hard to keep formed in, owing to changes of figure incident to changes of course, since ships in turning do not follow the arc of a circle, but the curve of some spiral shape. Naval square although hard to attack, it is not a very offensive formation, since the ships have not all their weapons available, gun-fire at least being confined to the outside ships.

We now come to the consideration of the *group* as a tactical unit.

The group is composed of three or four vessels disposed at the angles of triangular or four-point figures. Those who pretend to know say that there is no especial virtue in the *number three* or in the scalene triangular figure; notwithstanding which, the group is generally associated in the mind with this favorite number and distribution of ships.

One of the vessels of the group is appointed *leader*, and generally occupies the forward apex of the figure. Sometimes the leader of the group is empowered to form his group into other simple forms as line and column. Where this is so, all prejudice against the group disappears, as the formation then comes within another category.

It is said that the *péloton* or group formation was originally intended for cruising purposes, and not as a fighting formation. During many years the students of this science were struck with the necessity of so dividing the fleet that the particular qualities of each ship could be given their proper value, and the division of the fleet into groups found numerous defenders. Until lately this has been a favorite system, since it was considered to develop in the greatest degree the following points:

1. Each ship's battery was clear.

2. Each ship was considered to be entirely unhampered in its movements as regards ramming.

3. There was the greatest mutual support between ships.

Tacticians now do not allow these good qualities to the group. It is now said that the leader is not free in the use of his ram, as his consorts are too close to him; and where the group is other than *scalene* in shape the fire is *not* unobstructed for all.

The consensus of naval opinion is against the group formed in a certain shape, and fought and kept in that shape. When the groups are permitted to change their shape, they are no more than small or auxiliary formations of some other arrangement of vessels, and it is not fair to consider them as groups at all. In fact, it would be better to form them in the line or column or *échelon* in the first instance, and so save the time they necessarily take to manœuvre from their triangular form to whatever other form they determine upon.

In Plate XIII, Fig. 4, we give several forms of groups, and the tactician who recommends them explains their uses as follows:

1. The equilateral triangle, for ramming or as a cruising formation.

2. The group on a line of bearing. For flanking an enemy, for defence against an attack by ramming, and sometimes as a formation for attack.

3. The group for evolution or for using the battery.

4. Group in column.

5. Group in line.

VI.

The simple formation in column, with distances between ships based on the length of their manœuvring areas, and the number of ships in column so few in number that the signals made from the head of the column can be easily read by the sternmost vessel, would seem to fulfil all the requirements of a good fighting formation. With large battle-ships, *four* are about as many ships as should be mustered in one column.

For broadside fire the column stands preëminent as a formation ; and even with the ram as a basis of attack many authorities prefer this arrangement of ships, striking the enemy at right angles to the line of general bearing of its formation, their reasons being: first, that each ship in line ahead can, as it cuts the enemy's line, use both broadsides; and, secondly, the rear vessel of the column can, without interfering with the other vessels, take advantage of the *mêlée* by the time it reaches the enemy's line, and use its ram to advantage. They consider, in making this departure from rather well-established ideas, that vessels nowadays have such great speed, and artillery, from its size, must be so slowly served, that the leader of the line ahead will not be punished so badly as formerly. Another advantage of this formation for attack is, that the rear vessels are protected, the strongest and most formidable ships leading into action.

Besides, the formation is the easiest one in which to keep or for reassembling. It is perfectly flexible, and can in a few minutes change to any direction. Each vessel is flanked by the next astern which can come up on either side. The vessels being in the wake of one another must maintain the same

speed, it is true; but by sheering to either side any vessel can take up any speed, or use its turning-power in any way. The artillery-fire for the broadside is entirely unobstructed, the ram, the bow and stern fire, and the torpedoes are certainly put out of action; yet by a slight sheer out of the line any or all of these weapons may be called into play.

On the other hand there are tacticians who refuse to admit that the column is in any way a good attacking formation. They charge that a concentrated attack of the enemy on the two rear ships would certainly destroy them before the van could turn and come to their assistance. Then, again, they say that, except for the rearmost ship, the ships are not free to ram: for any ship to sheer into an enemy out of the formation means the possibility of interfering with the next ship ahead, and having the ship next astern run foul of her as well. It would seem, however, that when the column is composed of but few ships, and the distance between them is guided by the requirements of their manœuvring areas, there is little danger to be apprehended from this last objection. The advantages of the formation in column for attacking the enemy are certainly very apparent when it comes to the manœuvring of the force in any direction.

Double column is an excellent formation for purposes of cruising, anchoring, and battle. One half of the ships composing the force in regular order are in one column, and the other half, also in the same order, compose the second column. These columns should be separated by an interval at least great enough to let the force form line on a line of bearing eight points from the front. It has no drawbacks in regard to vessels being able to leave the formation, as they can always do so by dropping out on the off side. All the weapons are

available, except guns on the side nearest the other column. Changes of direction are nearly as easily made as in column. The leaders of the two columns keep abreast one another.

Indented or alternate column gives ships the advantage of using *all* their guns; but the formation is a hard one in which to manœuvre, not being flexible.

Column of sections differs materially from double column, since the two columns are only separated one distance. It will be noticed that instead of the columns being made up by the formation being divided into two parts, the vessels abreast one another are composed of a complete section—a leader and its mate,—and each vessel is the tactical counterfoil of the other; so that in case one vessel of the section is weak offensively as far as entering the combat is concerned, but is strong enough after it arrives at the proper position in the engagement, it devolves upon its mate to bring her up to the advantageous point. This explanation in regard to the section applies to a remark made in an earlier chapter, that the rank of the commanding officer of a ship should not determine the position of his command in the formation, but that this question should be one of tactics alone.

In double column it will be observed that the ships in each column are *one distance* apart, while in column of sections they are at *double distance*. This is of necessity the case, as the column of sections manœuvres by means of the *wheel*, and needs this amount of room for the purpose. Using this method, the movements of this formation are quite as easily made as manœuvres in the case of formation in column.

In all formations in more than one column the ships are well disposed for reading the signals of the admiral.

VII.

It would seem, in looking over all that is urged in favor and against the several formations, that the situation resolves itself into this : for cruising and for battle, simple formations composed of a few ships each, with the small formations mutually protecting each other's flanks, are the best. For anchoring, any formation is good which permits the flanks to be reinforced by combatant ships not of the line of battle.

The ideal formation, as far as manœuvring is concerned, is the single column of four ships.

In respect to the tactical unit, there is perhaps a feeling in favor of the section over the single ship with her torpedo consorts. With the section, the two ships are alike in speed and turning qualities, and *supplementary* in regard to weapons and defensive powers. With the line-of-battle ship and her torpedo-boats, the weapons of offence are alone supplementary, while all the other qualities are most unlike.

VIII.

Evolutions.

Evolutions in naval tactics have for their object the assembling of formations and the passing from one formation to another. They must satisfy the following requirements :

1. They should be done in the least possible time.
2. They should be spread out as little as possible.

There are six methods of evolution : those controlled by—

1. Simultaneous movements ;
2. Successive movements ;
3. Direct or oblique movements ;

4. Conversions;
5. Isodromes;
6. Wheels.

In all evolutions performed by a fleet at sea in the presence of an enemy, the one important point is that they should be quickly understood by the commanding officers of the ships composing the fleet. To attain this very desirable result, it is necessary—

1. That the signals should be as few in number as possible;

2. That the explanation attached to each signal should be as explicit and concise as possible;

3. That the officers of the navy should be instructed in the manner of performing the manœuvres as early in their career as possible.

Since changes in naval warfare are constantly rendering changes in ships necessary, changes in ships bring about changes in evolutions and also in the manner of performing them. These changes necessitate changes in the signal-book.

The knowledge of the helm, the speed of the ship, and the elements of the turning-circle certainly furnish the basis for all evolutions. There will be some difficulty in manœuvring a fleet composed of vessels varying greatly in speed, turning-power, and armament, so as to develop the special qualities of each ship; therefore it may be set down as a maxim, that the actual capabilities of the worst of the vessels comprising a fleet must be taken as the representative capability of such fleet. So that the maximum speed of the slowest ship is effectively the maximum speed of the fleet, and the circle of the ship which describes the largest is, effectively, the circle on which every vessel in the fleet has to manœuvre.

It seems, therefore, to follow that the power of a fleet as a

fighting unit may be improved by the rejection of those vessels whose power of manœuvring is bad.

On the other hand, any evolution is of no value when a ship's speed or turning-power is interfered with to the extent of reducing her usefulness below that which the ordinary good qualities of her engines or helm would demand; such as, for instance, making a wheel with four vessels: the inner vessels would have to go at such a slow speed that they could not keep their positions.

It may be set down as a general principle, that no evolution is of merit which employs such a method, to pass from one formation to another, as breaks up the mutual support which should exist, in all good tactics, between the ships of the force.

The only circumstances under which a vessel is authorized to stop, when steaming in squadron, are the following:

1. To save a man overboard.

2. In case of an accident to the engine, screw, or rudder.

3. To avoid a collision.

In almost every case the vessel which stops should drop out of line, by sheering to that side which interferes with the other vessels the least.

In any movement made by a fleet in performing an evolution there are the following requirements to be fulfilled:

1. To lose as little distance as possible in passing from one point to another.

2. To avoid any possibility of collision between two or more ships of the fleet.

3. To keep the fleet in such a condition as to form order of battle easily and quickly.

We may also state that the nature of all movements of a line of battle presents three phases:

1. To approach the enemy—bow towards him.

2. To keep at a certain distance from the enemy—broadside towards him.

3. To retreat, or increase the distance from the enemy—stern towards him.

Even with a small number of vessels, no movement can be made, with the enemy bearing down upon you, inside of four miles' separation. If an evolution *must* be performed, it would be better to charge through the enemy's line, in the formation in which you happen to be, and form on the other side. You have been caught at a disadvantage, you must make a run for it, and this is the safest way to gain time to perfect a formation.

We have now presented about all the principles involved in the evolutionary systems of the last twenty years; only those in future will remain which fulfil the following conditions:

1. The ships must cover the least space at full speed without danger of collision.

2. The evolution must be feasible at night as well as by day.

3. During the evolution the ships must be formed, and be able to give each other mutual support.

4. If possible, the broadside must not be presented to the enemy's line of rams.

IX.

Theoretically, in simultaneous movements every ship puts its helm over in the same direction at the same time; practically, the ship that has no vessel on the side towards which she turns should commence—as, for instance, the rear ship of a

column, or the ship on the flank turned towards, of a line—as soon as the manœuvre is marked, then the next ship to her, and so on.

Some tacticians assert that simultaneous movements—i.e., change of head—are the only manœuvres that can be used in action; but this can hardly be the case, as nothing like any tactics—concentration for instance—could be attempted. Indeed, the majority of writers agree that the only movements in combat are successive movements, since they not only require no change of speed, but the course and distance passed over by the force is correctly known.

Those who believe in the value of direct movements say that rectangular (successive) movements are inapplicable to a fleet of armored vessels in which fighting by means of the ram enters. This point of the ships always presenting their bows to the enemy when manœuvring by the direct method is not nearly of as much moment as is the fact that from the time the ships leave the old formation until they are completely formed in the new one they are in *no formation at all;* which is a very telling point against direct evolutions—for if you can do as well in a fight unformed, why take up the time and trouble of sustaining a formation? The direct method suffers by comparison with the successive method, as will be seen by the following example: If there was a force of ships in column, and line was directed to be formed, the direct evolution with eight ships and a standard speed of eleven knots would only be completed two miles from where the evolution began, and would take twenty minutes. If the rectangular method was used the evolution would be accomplished in eleven minutes, and only eight hundred feet ahead of the point where the evolution started.

Some favor the use of both systems, the admiral to be governed by the environment in regard to which method is the best to use. Each of them has its drawbacks. With rectangular methods, if we are manœuvring in the presence of the enemy, our broadsides are exposed to his line of rams; with direct movements collisions are liable to occur, and the fleet is without order until the new formation is complete.

Conversions are clumsy and slow for more than four vessels, and should never be attempted in the same waters with the enemy.

Isodromes, or "paths of equal length," form a very ingenious method of keeping up a single speed and yet keeping the force compact—so it is claimed—and in hand: it is applicable to the manœuvring of more vessels in simple line than any other, although it is a method which must require a good deal of drill to make it efficient. It must be said for the isodromic method, that in the case of a force manœuvring in it in the presence of the enemy, each vessel is pretty well covered by the remaining ships from any onset of the enemy for purposes of ramming. With much smoke present it would be impossible to use this method.

A *wheel* is a simple method of manœuvring two ships in such a manner that their relative bearing, and therefore their mutual protection, remains at all times the same.

X.

The admiral may arrange for himself a position in the formation, and may designate some vessel, not of the line of battle, to assume it, should he wish to keep withdrawn for some reason.

In our service two vessels constitute a section, two sections a division, and two divisions (eight ships) a squadron.

When changing from line to column by the rectangular method the distances between ships must be great enough to permit the helm changes required without danger of collision, or else the flank vessel formed upon, sheers through five points, and then comes back to the course in order to give the necessary room to the other ships of the force to turn in.

Ships following a leader in column should when manœuvring avoid turning on a greater arc than that of the leader; if there is any error or difference, it should be due to turning on a smaller arc. As a rule, when a ship has turned wide on a leader, following ships should turn on the guide of their column, and not on the ship that has got out of station and has to recover it.

When in column any error from the exact station of a ship should be in the direction of being ahead of station; but when in line, any error should be in the direction of being astern of station, rather than ahead of it.

CHAPTER VII.

THE FLEET IN ACTION ON THE OPEN SEA.

I.

UNQUESTIONABLY some formation for attack is necessary, and the fight must be conducted after some method. To fight in no formation is to add the dangers of collision with ships of your own force to the surpassing horrors of the modern battle.

Many tacticians, as we know, have striven to contrive some formation which will answer for all kinds and conditions of ships, and be of value throughout the whole time of the engagement. This is now conceived to be an impossible task.

Ships of the line of battle require free use of their weapons, and can only afford to give up certain offensive qualities to derive the greater benefit which might accrue through increased security from an attack of the enemy. This they are enabled to do by adopting those formations which suit their eminent weapon best; and although these formations may not be the ideal arrangements in which to manœuvre, they should be chosen, provided they are simple, and the ships so formed are few in number. For instance, ships with heavy rams and great weight of bow-fire would naturally develop their powers better when formed in line; broadside ships would do best when in column, and rams in columns or column of sections.

All the formations adopted should be so disposed, in regard to interval and bearing, as to give the greatest independence of action and movement of the formations, and yet preserve the strongest mutual defence for the whole force of ships.

The force should enter the attack in the following order:

1st. Bow-fire ships with good ramming power;

2d. Broadside ships;

3d. Rams.

These should engage the enemy at such intervals of time one after the other, that the enemy could not change his formation or arrange his force for concentration between the time of encountering one force and encountering the next. This would offset any weakening likely to arise from dividing up into many small formations and increasing the number of the exposed flanks.

Fresh material in this way, being put upon the enemy, will prevent him from knowing what formation he will next engage, will not allow of his re-forming to meet any change, and cannot but fail to have a very demoralizing effect upon him.

Inseparable from simple formations are simple evolutions. These must be confined to successive and simultaneous movements.

The advantage of having one force follow another instead of having a compound formation is best shown by an illustration. The enemy in some formation meets your first force, which we will take for granted is smaller than his own. Your second force in the same or preferably in some slightly different formation, but independent as regards manœuvring with the first, is in sight.

Contact between the enemy and your advanced force takes

place. This latter, either crippled or not, gets in the rear of the former. The enemy cannot turn, as he is confronted by your second force, to fight which under the best circumstances he should perhaps re-form, which he cannot do. Therefore the second force has probably an advantage, and can cut off part of the enemy's formation. This would likely demoralize the enemy to the extent of permitting your rams, which should now arrive, free to move—two on his one ship. By this time your first force, *which has manœuvred without being under fire*, has returned, and a conclusion should soon be reached.

In respect to the time when torpedo-boats should enter the fight, it is believed that their opportunity is to be found any time after the first encounter, when they can have the smoke to protect them.

Torpedo-boats in a pitched battle between fleets should hang about their own line-of-battle ships.

II.

The following tactical directions may be considered fundamental:

1st. During the execution of a manœuvre determined on beforehand or ordered by signal, and which has for its object the bringing of the fleet into action, no vessel must change course except to prevent being rammed.

2d. Mutual support would point out the necessity of not separating. The grand object will be to keep together, and prevent the enemy from concentrating on any point.

3d. When once the ranks are broken, it is imperative to

keep a lookout on the flag-ship for signals, although the fighting of each ship as an individual must not be relaxed.

In all charges, having once passed through the enemy's line, it must be well understood beforehand how the vessels are to turn—whether to starboard or to port. This should be governed by an inflexible rule. If it were arbitrary, confusion and disaster would certainly follow.

Plans of battles, as far as practicable, should be arranged so that when the enemy heaves in sight he can be attacked without numerous signals being made. After the battle has once commenced signals should have reference alone to strengthening the line in some designated direction, ordering one formation to join with some other, rallying, retreating, or which would arrange the fleet in such a manner as to consummate the ruin and rout of the enemy.

The enemy should be attacked, no matter what your formation is, if he attempts to pass from one formation to another.

There are five rules laid down for the use of guns in a general action :

1st. Guns are on no account to be fired unless there is every probability of their taking effect.

2d. The broadside guns will always be trained on some prearranged bearing, from abeam to 15° before the beam, so that the captain shall at all times, and without giving a second thought, be certain of the exact direction in which his guns are pointing.

3d. Guns as a rule will be fired by broadsides.

4th. A disabled ship with rudder or engines broken down will use her guns to the utmost of her power.

5th. As far as possible, the aim is to be directed at the weakest points of the enemy.

The mode of concentration differs for whichever arm of warfare is put into action. There are three methods for concentrating in artillery engagements the batteries of a certain number of your vessels on a smaller number of the enemy:

1. By cross-pointing (concentrated fire).

2. By the passing of the fleet before the one point assailed in the enemy's line in column.

3. By catching any ship or ships of the enemy between two fires (doubling on the enemy).

This last method of concentration consists in penetrating the enemy's line, to take between two fires each of the vessels of that portion attacked. The fight should take place at close quarters. This system of warfare leaves out of the fight a portion of the enemy's fleet which will seek to enter the *mêlée;* but if the concentrating movement has been quickly executed, before the unattacked portion of the enemy has had time to get into action, a decisive result should have been attained.

Considering the question of concentration in regard to rams, two rams cannot well attack the same vessel at the same instant; still, the two can act in concert, either on the same broadside of the enemy's ship or one on each side, provided their courses did not converge. In each case the attacked ship should endeavor to bring about a collision between its assailants.

The attacking vessels should preferably ram the enemy's ship one after the other; therefore any number of vessels can be concentrated for ramming on one of the enemy. In artillery concentration, however, only two, or at most three, ships can be used against one of the enemy.

Concentration for torpedo attack resembles somewhat the method used for ramming. If the torpedo is carried ahead on a spar or installed to act right ahead (if of the automobile type), the methods are identical.

III.

A force moving on the enemy must do so in some order; an advance as a mob means defeat. Individual dash is inferior to system, even should that system not be the best. Let the rule be to keep confusion away as long as possible.

Formations must be compact enough to guard against having the line of battle broken in upon; but great compactness necessitates thorough drill, as an accident happening, such as a collision, would be likely to entail very serious consequences.

Should the formation disappear for each side without either party having the advantage, then the chance of victory would lie with that force which could re-form the sooner. If, in the midst of an engagement, the admiral considers it necessary to re-form the line of battle, he should signal his fleet to draw out of action and to form on *him*, either in the formation in which the attack was made or in some other, as signalled.

On the disappearance of the formation endeavor to hold on to your consort and work with him, and add as soon as possible other ships of your force that you may come across. As you return to the attack, concentrate upon any injured ship of the enemy and put her out of the fight. Keep at the same time your eye on the admiral's ship for a signal to re-form.

It is always in order for any ship in formation where she finds herself unexpectedly in a position of advantage to ram

an opponent to do so on the instant. There must be no mistake about this, however.

It will be remembered that it takes some little while to load and fire the largest guns, so that where two columns are passing each other, if the guns of each ship are all fired at the leading ship as she passes, the other ships will receive no heavy gun-fire at all. Several rules have been laid down to meet these conditions: one is, that the first ship shall fire at the enemy's leader, the second ship at the enemy's second ship, and so on; another is, that the first two ships of the force shall fire at the enemy's leader, and the next two at the enemy's second in column. The constitution of the enemy's fleet, from what you can discover about it, will in a great degree decide your action in this particular.

Your column breaking through the enemy's formation should do so in a manner to divide his force unequally. In doubling on his smaller portion, the object would be to get his ships *out of the formation and headed away from it.* If your ships are swifter, and if you can put two on one, you should be able to demoralize him completely by scattering his ships so widely, let alone ramming them, that they could never regain the other portion of their force.

The modern battle-ship is more easily rammed than the well-protected cruiser, being slower, and will perhaps sink sooner, being heavier, and a greater number of people will be destroyed on account of the battle-ships' companies being the larger.

The well-protected cruiser in an artillery fight will be destroyed where the line-of-battle ship will be but slightly injured. The cruiser, though, could take to her heels if necessary to save herself from destruction.

In action the fires will all be lighted. Speed should be as great as the state of drill will permit. High speed may be considered as the first *indirect* protection against ramming. When the formation disappears, the speed of the ship is governed as an individual; while the formation is intact, the speed is governed by the speed of the slowest ship of the force.

IV.

There is no use in firing your guns unless you can see what you are firing at: if the smoke prevents this, it would be wise to cease firing until your target comes into view. If this matter of smoke ended here it would not be so bad; but unfortunately it might happen that just as you were doing some brilliant artillery work the smoke which you created would serve to conceal the approach of rams and torpedo-boats, which might succeed in sinking you.

Ramming in fleet fighting will be against the rear ships of your formation by the rear ships of the enemy. This means the *mêlée* will begin by a pitched battle between the rears of the two fleets. The van will strive to get back into the battle as individuals as quickly as possible, and all formation will be at an end.

Can this be avoided? It should be, for the giving up of one's formation is the immediate throwing of one's self on one's own resources. Considering the matter for yourself, who can tell what chance will bring to you in the next minute—an enemy, perhaps your superior in either offence, defence, and position, or perhaps superior in all three! It would be better if, when you are rammed at by the enemy, you could avoid the attack and stick to your consorts, and when you are out of

the fire and fury of the onset, turn and go back into the thick of the fight with the rest of your disciplined force; but hold on to your formation first, last, and all the time.

In regard to concentration, it will be of little or no use between equal forces, except in the case where the fleets are very large. A concentration may be either *total* or *partial.* If a fleet is arranged for a ramming encounter, and its number of rams is double the number possessed by the enemy, the formation for attack in two lines of equal length is naturally indicated. This is a total concentration. If the number of rams of the two fleets are equal, this method will not do, and a partial concentration must be made on some weak point in the enemy's line. In a concentrated attack the first line should be composed of the heaviest armored vessels, the second line preferably of rams. The first line is to use its artillery only. Ramming attacks on the broadside of a vessel, the rammer describing a quarter of a circle, are based upon an appreciation of the speed, essentially variable, of the adversary. This manœuvre presents only a very few chances of success, if we reflect that with a speed of ten knots a vessel passes over her length in fifteen seconds.

In lines the flanks should be protected by other vessels not belonging to the formation, but which act as a reinforcement.

The use of automobile torpedoes does not seem to have modified the tactics of combat on the open sea in any way except in some special cases, as, for instance, fighting in chase or retreat.

In the *mêlée* automobile torpedoes are as dangerous to friend as to foe, and must be used with the utmost caution. Each captain cannot calculate in advance what he will do, as

in a duel between ships. Every moment will bring forth something unexpected. Hence the reason for our asking the question as to whether the automobile torpedo will or will not be used during the *mêlee.* All we can say is, that circumstances will alone decide its employment. Everything is given up to the unforeseen. One vessel starts to ram another; suddenly she is obliged to modify her tactics, to escape a ram from a second adversary; some other vessel, going to the succor of a consort, comes on top of an enemy, till that instant unseen on account of the smoke which obscures the field of battle. If this is true of ramming, where the missile, so to speak, can be stopped in its flight and its course changed, how much greater would be the responsibility of using a weapon which, after it is discharged, can in no wise be governed!

During the fight, the duty of the squadron of cruisers, if it is seen fit not to employ them in the line of battle, would be to keep well clear of the ships of the line, and be ready to assist damaged ships, cut off torpedo-boats, and harass and destroy the enemy's smaller vessels.

Torpedo-cruisers and seagoing torpedo-boats should move in and out among the enemy where it is not too hot, and especially keeping a lookout for disabled ships. It is thought, though, that instead of forming an advance line and entering the action before the field of operations is obscured by smoke, and when they can be the more easily driven off by machine-gunfire, their time for gathering the best fruits of the contest will be *later*—during the *mêlée.* Indeed, it would seem to be a a maxim that victory will lie with that fleet whose torpedo flotilla is first in action *after* the first charge.

Where torpedo-boats are too large to be carried, and are

too small to keep the sea in all weathers, they hamper the fleet in two ways:

1st. The fleet can only move when these boats can take the sea.

2d. If these boats are forsaken or sent into port for shelter, they with their care-takers will not only fall an easy prey to the enemy, but will advertise to the enemy the propinquity of the force.

V.

Should a fleet be surprised by an enemy when in no formation, each ship's bow should be turned towards the enemy, and a charge made through the enemy's line. When the other side is reached, they should form in the chosen way for retreat, and fight the now turned and attacking enemy, or, if the occasion presented itself, turn simultaneously and attack their pursuers.

During an engagement, if the admiral wishes to retreat, the line of battle, by a simultaneous movement or otherwise, as soon as possible should come into some retreat formation. The preferred formation for retreat is column; in which case, if it is assumed, the best ships should be kept in the rear nearest the enemy, the lighter vessels towing the disabled ones.

To attack a fleet at anchor, use the ram, each vessel choosing a ship of the enemy to attack. A fleet at anchor must depend for its defence on torpedoes, mines, and booms, together with its flotilla of torpedo-boats. A fleet surprised at anchor is a contingency of war hard to realize. A fleet, however, caught in this manner would undoubtedly be destroyed.

CHAPTER VIII.

THE SEA ARMY FOR OFFENCE AND DEFENCE.

I.

SHOULD a fleet regularly set out from home or from some friendly base, to besiege a port or establish a blockade, the nature of the work to be done would in a great degree decide the class and number of tactical elements entering into it. Besides the force of line-of-battle ships, and squadrons of ships composed of cruisers, corvettes, gun-vessels, tenders, and torpedo-vessels, there will be a semi-naval establishment of heavy wrecking-tugs, surveying-vessels to establish lights and buoys, launches, mining and countermining vessels, telegraph and cable-laying vessels, as well as search-light vessels furnished with powerful electric-lighting devices. Likewise we will have coal and ammunition vessels, commissariat and naval-store ships, hospital ships, and floating repair-shops.

The line of battle will ordinarily be composed of lighter vessels, in part, than if the combatant force were designed to meet the enemy at sea. It would contain coast-defence vessels, monitors, turreted vessels, and rams.

Perhaps, too, there will be a large force of troops embarked in transports, accompanying the fleet.

The progress of this sea army is termed a *sea march.* In this case the line of battle acts as a convoying force to the non-combatant ships ; it may be divided to perform this work,

but it must not be so widely separated as to break up entirely the mutual protection of its parts. The cruisers will be constantly employed in keeping the convoy in order and in towing disabled ships. The scouts must be thrown out to long distances in every direction. The vessels of this army will be so diverse in seagoing qualities that the speed will be very moderate. Rendezvous will be arranged for and will be frequent, and the non-combatant portions of the force must be given specific instructions concerning making friendly ports.

All these various elements, with their multitudes of experts and *attachés*, must be protected by a powerful convoy-guard regularly attached to them, and commanded by a flag-officer, who will especially be charged with getting them clear of the field of battle, and into some place of safety in case of collision with the enemy. The convoy should be divided into squads of *eight*, and two war-vessels should constitute a guard for this number of ships.

II.

The attack upon a harbor or position on the coast involves three distinct operations:

1st. The penetration of the port, or the getting into a commanding position.

2d. The bombardment, or control of the enemy's fire.

3d. The disembarkation of troops, and occupation of the military position.

In regard to the attack upon fortifications by ships, certain tactical experiences have been undergone by the combatants, which have found expression in the following conclusions:

1. Although vessels engaging forts will never be able to

fight on equal terms with them, still forts will offer but little resistance to vessels attempting to run by them.

2. Under all circumstances the fleet should keep away from forts whose guns are mounted high above the sea-level on account of the danger to be incurred from a plunging fire.

3. Any projection appearing above the crest of the parapet of a fort furnishes an excellent target for the attacking fleet. It is a means by which the position of the guns is readily indicated and located, and which advantage the ships should be quick to seize.

4. Recent high-powered guns are not adapted to bombarding earthworks. Ships for general service should have a composite battery.

5. Ships should engage forts at moderate distances. With close range and a stable platform great damage can be done by shrapnel and machine-gun fire.

6. In all bombardments the target for the fleet should be—

(*a*) The guns of the enemy actually firing;

(*b*) Any building believed to be a storehouse or magazine.

7. An advantage possessed by a vessel with a heavy fore-and-aft fire lies in its ability to anchor head to sea and engage a fort either ahead or astern from a comparatively steady platform.

8. If the ships and forts are about equal as regards artillery, the ships had better anchor. If the forts are the heavier, the fleet should fight under way.

In entering an enemy's enclosed waters it will be necessary to have a countermining flotilla precede the fleet where planted mines are suspected. Armored vessels built for coast and harbor defence, but which can be taken to sea, may be of great use in an enemy's harbor where torpedoes and mines are feared,

to be pushed forward in the van in place of the more valuable armored line-of-battle ships of the force, since they have, as a general thing, great artillery power and good resisting qualities for their size.

Among the most useful elements of the besieging fleet is the telegraph-cable vessel. The cable-laying flotilla should consist of the tank-vessel containing the cable, small vessels to be used as receiving-stations, and tugs for the heavy weighing and handling of buoys. The tank-steamer should be capable of laying out and picking up the cable, and should be in every way fitted for telegraph testing. The tugs will be used to run the lines on shore. The cable as regards size should be a compromise between the shore-end and deep-sea cable, so as to stand well in shoal water, and to permit of its being picked up and laid down many times.

In order to protect ships obliged to remain at anchor, they must be surrounded with mines, booms, and nets, besides being guarded by torpedo-boats. The mines, carried by special ships, are as much part of the outfit of the besieging force as they are of the besieged.

A vessel occupying the position of a blockader will be exposed to an attack from—

1. Automobile torpedoes from a gunboat or torpedo-boat;
2. A spar-torpedo from a cruiser, gunboat, or torpedo-boat.

The ship if attacked can defend herself by—

1. Running away;
2. Sinking the attacking vessel before she has time to use her torpedo;
3. Fighting the approaching vessel with guns and her own torpedo-launches;
4. Using nets, booms, etc.

The first method is hardly to be thought of. If it were used the enemy could keep the fleet constantly driven off.

The second method is more practicable. The attacking vessel must, however, be destroyed before she can approach within 600 yards. A heavy fire of manageable guns should be kept upon her. The only drawback is, that if the guns do not sink her, they will give her the chance she wishes to have, that is, an abundance of smoke to work in.

The third method is not to be entirely depended upon, because the enemy may glide between your launches—injured perhaps by your attack, but not disabled.

The fourth method is hardly satisfactory, but when combined with the second and third it seems all that is left to us. The moving torpedo-boat is a small object and moves rapidly, and consequently is hard to hit; but, on the other hand, it is easy to sink if your shot strikes it.

Since large blockaders will retire during the night to some outside line, in localities where they are likely to be harassed by torpedo-craft, it will be perhaps arranged to have a telegraph-cable laid between the inshore and offshore blockading lines, with vessels lying to either end of it, so that the earliest notice of any movement on the part of the enemy can be given. Should there be no cable provided, provision must be made for establishing a line of corvettes or gun-vessels to transmit information by signal to the large vessels. Small vessels will take the inshore blockade at night.

III.

The blockade of a whole coast of a country possessing a navy is impossible; even that of a single port is difficult. Under any circumstances it can only be rendered effective by

the concentration of numerous squadrons écheloned, as it were, on several concentric circles whose centre is the port to be blockaded.

It has been decided by experience that up to the present time—

1st. Blockades are still possible if proper precautions are taken by the blockading fleet.

2d. Fleets at anchor should be protected by triple booms, and these should be protected by guns and mines.

3d. The electric light, when intended to protect ships at anchor, should be used from special ships or boats throwing *fixed beams*, the distances of which from the armor-clads lying behind the booms should be known.

4th. Guard-boats if used should have special orders and signals, so as to keep clear of the fire of their own ships, and not to hamper or interfere with it in any way.

5th. Special depot-ships should carry booms and nets so as to enable the booms to be rigged rapidly.

The following maxims relate to an attack upon a harbor defended by mines as well as forts :

1st. A systematic attack on the mine-field must be made, so as to clear a passage broad enough for single ships (at least) to move up and bombard the batteries.

2d. The ships must be powerful and numerous enough, when there, to silence the enemy's forts.

3d. The van ships must be well protected by nets, or the best means at hand, against torpedoes.

4th. The attack once begun must be continued until the channel is clear and the batteries silenced. Care must be taken to have small and handy craft stationed about to pick up and destroy mechanical floating mines sent down by the enemy.

5th. Vessels moved against the enemy may be fitted beforehand in any way that would facilitate raising them in case that they were sunk, such as slinging them with chains, discharging coal and stores, and maintaining their draught by means of weights easily got rid of if the ships were wrecked, such as ranges of chain-cable.

In considering the defence of a vessel from an attack by torpedo-boats, as far as artillery is concerned, each gun must—

1. Be easily trained, permitting it to follow all the movements of the enemy;

2. Be capable of rapid loading, so as to fire the instant the aggressor comes in sight, and to keep it up;

3. Have the projectile heavy enough to injure seriously a gunboat or sink a torpedo-boat.

In the opinion of some tacticians there is only one certain means for driving off the enemy's torpedo-boats, and that is, to fight them with your own. The question then immediately arises, How does this class of vessels fight? Not with automobile torpedoes, because the target is too small and too changeable for a torpedo; besides, the boats are not deep enough in the water. Two torpedo-boats could not ram one another without both being used up. The way will probably be, each boat will attempt to destroy the other by means of small gun-cotton spar-torpedoes, by mechanical gun-fire, or by the use of hand-grenades. It should be the aim of a combatant to try and kill the crew of its adversary, as it is to be supposed that it is composed of skilful and daring men, and that their loss will be felt.

IV.

It still remains for us to discuss the question concerning an attack by torpedo-boats upon ships or a ship under way.

Let us recall the fact that the discharge of the automobile torpedo is subject to grave drawbacks, arising from a false appreciation of the speed and course of the enemy, and, furthermore, that this is aggravated by darkness. At the outset, to aim at a moving target with a vessel which itself acts as a gun-carriage, especially where there is a little sea on, constitutes a very delicate and involved operation—very much more difficult than where the automobile-torpedo tube is installed in a ship of some size. Admitting that an automobile torpedo can be discharged effectively 500 yards from an anchored enemy, we are generous when we allow 250 yards as the effective range of an automobile-torpedo boat firing at a vessel under way.

Suppose a ship (*N*) with a speed of 12 knots (see Pl. XIV, Fig. 1) is obliged for some reason to follow the line *NN'*. An automobile-torpedo boat (*L*) going at 18 knots speed, which has been discovered by the ship bearing forward of her starboard beam, so directs her course as to arrive at the point *L* abeam of *N* when she is at *O*, and 250 yards off. Here *L* discharges her torpedo, which has a speed of 24 knots. This done, the boat turns through the arc *L*, *L'*, and moves away in the direction *d*.

The ship has opened and ceased fire at a distance of 1500 yards on the torpedo-boat. The torpedo-boat has been under fire about $2^m\ 53^s$.

Now let us look into the movements of the spar-torpedo boat (*P*) manœuvring under the same conditions. If it should fail to explode its torpedo under *N*, it would go astern of the ship at *O*, then describe the arc of a circle *O*, *P'*, and run off in the direction *c*. Therefore it would be under fire but little longer than would the automobile-torpedo boat *L*. If, however, *P* succeeds in exploding his torpedo under *N*, he will remain stopped before the explosion and after it during a time hardly exceeding 30 seconds, then the ship would have forged ahead sufficiently to permit him to describe the curve of *O*, *P'*. The torpedo-boat *P* then would have remained exposed to the enemy's fire for about the space of $3^m\ 23^s$.

Let us now consider the case of an attack by an automobile-torpedo boat coming down from ahead upon a vessel which is obliged to follow the course *N*, *N'*, *N''*.

The torpedo-boat has a speed of 18 knots and the vessel (*N*) 12 knots (see Pl. XIV, Fig. 2). Fire commences and ceases at 1500 yards. *L*, *L'*, *L''* indicates the positions of the torpedo-boat corresponding to the positions of the ship *N*, *N'*, *N''*. The torpedo-boat discharges its automobile torpedo from a distance of 250 yards, and then describes a curve of 175 yards with a speed of 15 knots. The torpedo is supposed to travel with a speed of 24 knots. Now if we calculate the time *L* is under fire it will be found to be $2^m\ 51^s$,—that is, only 2^s less than is the case in Fig. 1, or the time taken up to describe the curve *L*, *L'*, which slight difference is owing to the fact that you are attacking a vessel which is approaching you. *P*, *P'*, *P''* show how a spar-torpedo boat would take up corresponding positions to *N*, *N'*, and *N''*. From the figure it will be seen that *P* will not be under fire much longer than will *L*, but charging the greatest amount of time that might be so

taken up against *P*, it will not exceed 30^s. So that *P*'s time will be $3^m\ 21^s$.

Finally, suppose instead of *L* and *P* coming down from ahead they came up in *N*'s wake (see Pl. XV, Fig. 1). The time for *L* under these circumstances would be $9^m\ 29^s$, and for *P* about the same or even a little less. It will be seen that it is always a disadvantage, for this reason, to approach your enemy from a direction on her quarter.

We have now, in a certain way, given a few theoretical examples concerning attacks by torpedo-boats on ships. We say *theoretical*, because the ship has been considered confined to a straight course. Neither of these conditions would govern a vessel (except in the case of a squadron moving along a channel to enter and capture a port); still, the simple calculations which we have given suggest two important remarks:

1st. The time during which a spar-torpedo boat remains exposed to an enemy's fire only exceeds by about *one sixth*; the time passed in an analogous situation by an automobile-torpedo boat, and in the case given in Pl. XV, Fig. 1 (coming up from astern) this time is even a little shorter for the spar-torpedo boat.

2d. A torpedo-boat, of whatever description, does not gain anything in the way of time by coming down from ahead on the enemy (as shown in Pl. XIV, Fig. 2) over an attack made on the enemy by coming up at right angles to the enemy's course (as shown in same Plate, Fig. 1). More than this, the manœuvre in Fig. 2 is more delicate, and there are fewer chances of the attack being successful. It obliges the torpedo-boat which undertakes it to remain a comparatively long time under fire at short range, if having missed exploding his torpedo effectively, he wishes to try it again. On the contrary, it is

relatively easy for a torpedo-boat lying off the bow of a vessel steaming ahead to attack her on the bow at right angles to her course as shown in Fig. 1, since it can at any moment change the direction of its head so as to engage the enemy by steering for her on the shortest line connecting them.

It is evident that in daylight the attack by one or more torpedo-boats on a ship under way and free in her movements will, in practice, not be governed by the conditions we have discussed, but at night such a condition of affairs might easily exist. Now, how will a vessel free in its motions act? She will certainly try to avoid being put in a position shown in Pl. XIV, Fig. 1; therefore she will either try and run over the attacking boats and sink them with her ram and machine-gun fire, or she will run away. We believe that in the majority of cases this last manœuvre will be the one executed. We have seen that this condition of affairs puts ordinarily a chasing torpedo-boat under the vessel's fire for ten minutes or longer,—something hardly to be thought of, so far as considering this a proper manœuvre for the torpedo-boat during the daytime. However, during the night, even with electric lights, we know that the torpedo-boat could with profit chase a flying enemy. But under these circumstances the spar-torpedo is a better weapon than is the automobile torpedo, since the aim with the latter would be inaccurate; and, furthermore, the former would have the advantage of gaining 20 seconds or more on the latter, for the reason that the automobile-torpedo boat would have to head for the enemy at a point *nearly abeam* of her, and 125 yards off, in order to fire her torpedo with a chance of success. It may be thought that this seeming disadvantage for the automobile-torpedo boat is offset by the danger that the spar-torpedo boat runs by having to absolutely

touch the enemy, thereby encountering heavier fire, and perhaps a counter torpedo and hand-grenades.

In these illustrations the automobile-torpedo boats are confined to firing their torpedoes ahead: if they can fire their torpedoes from the beam, all that portion of the time which has to do with turning towards the enemy can be eliminated from the time they are necessarily under fire; which fact alone would give the automobile-torpedo boat a tremendous superiority over the spar-torpedo boat, except under the circumstances to be detailed farther on.

At the outset, let us consider a ship menaced by two automobile-torpedo boats (see Pl. XV, Fig. 1) L_1 and L_2, and by two spar-torpedo boats P and P'. The first mentioned are obliged to run past the ship to attack, one on the starboard side, and the other on the port side, leaving between them a space of 600 yards. At this distance, in night-time, they will not be able to attack simultaneously, as they ought, since they could not see one another; for instance, the starboard one might run beyond her consort and may be at L'_1 the desired spot, while the other only gets to L'_2. At this moment the ship whose turning-radius is 325 yards, would only have to change course eight points to starboard to make the attack miscarry. The two spar-torpedo boats P and P' can, on the contrary, act together, as they can keep near enough together to see each other. Should the ship turn in any direction, they can do the same. Should the two automobile-torpedo boats both attack on the same side, she can always keep away from them by turning, and can extend the time of their being under fire long enough to destroy them.

Nevertheless, certain circumstances present themselves where an automobile-torpedo boat, whether crowned with

success or not, offers so many chances of immunity from punishment by machine-gun fire, that there should be no hesitation to attack and profit thereby. During a dark night she could, for instance, steal upon a vessel within 300 yards, no matter if the enemy was furnished with electric search-lights, discharge her two torpedoes and draw off without being seen.

Although single vessels will not follow certain courses such as we have supposed *N* to do in Plate XIV, still, when we commence to look into the movements of a combination of vessels formed in column to force a passage, we encounter a state of affairs resembling for each vessel the one we have laid down in the diagrams referred to. In effect, each ship must follow her leader to prevent breaking up the formation or to escape danger,—generally a narrow channel filled with natural or artificial obstacles.

If possible, torpedo-boats in attacking squadrons trying to enter a harbor should unquestionably take advantage of ambuscades, natural or otherwise, and should endeavor to appear and discharge their torpedoes on a line perpendicular to the enemy's course.

Now, for such a manœuvre, which is best—an automobile-torpedo boat or a spar-torpedo boat? Let us see. The time that the last mentioned will continue under the fire of a single ship steaming ahead maintaining its course, we have already said, only exceeds by one sixth the time applicable to an automobile-torpedo boat under the same circumstances; but we will see that a spar-torpedo boat when it encounters a *squadron* has its proportion of danger made much greater than that which menaces the automobile-torpedo boat doing the same thing.

A force will attempt the passage into a harbor, for instance, probably formed in column or in one of its derivations.

Let us consider the case of a force entering, formed in two columns. Distance between ships, one cable; interval between columns, two cables; speed, 10 knots. (See Pl. XV, Fig. 2.) A spar-torpedo boat (P) coming down from forward of the beam of the leading ship of the enemy (E) manœuvres to explode his torpedo against the broadside of N'. It will take him longer to disengage himself from his opponent (since the ships N'', N', and N_2, etc., will prevent him from circling) than it would an automobile-torpedo boat.

Now less than 40^s suffices for N'' to cover 250 yards and come to the rescue of her consort, N'. Therefore N'' can turn slightly to starboard, and not only add her fire to N''s to disable P, but in all probability she could run P down.

If P, on the contrary, has failed to explode his torpedo, and passes astern of N' in hopes of picking up N_2, for example, he would find himself between two lines of the enemy, and in a fire which he could not stand. An automobile-torpedo boat, however, could advance to within 250 yards of the passing squadron, discharge its two torpedoes, and withdraw, either on the arc L, L', or by working its head in the other direction. Besides this, if the torpedo is arranged to run 800 yards, it is possible that missing a vessel in the right column it might pick up a victim in the left one.

Although it is to be seen that an automobile-torpedo boat has a certain advantage over the spar-torpedo boat in action, and that any improvements made in the discharge of her automobile torpedoes which permit her to use them at any speed, making a course at any angle with the enemy, add greatly to that advantage, still the spar-torpedo boat has an important

part to play, and should not be omitted from among the factors for war.

In the *mêlée* the spar-torpedo boat would have an advantage over the automobile-torpedo boat, as the latter would be afraid to use her torpedoes, since an enemy missed might mean a friend destroyed.

To sum up, then, in respect to vessels at anchor:

1. Automobile torpedoes are best used on a night relatively clear and without fog, with a calm sea, when there are weak currents or none at all, and when the enemy is defended with obstacles of less resistance than metallic nets.

2. Spar-torpedoes are, on the contrary, best used on a dark night, and with the water a little rough, in the midst of strong currents, and against vessels strongly defended with obstacles.

The following conclusions refer to ships under way:

1. There is hardly any difference between the time that an automobile-torpedo boat and the time that a spar-torpedo boat will be exposed to the enemy's fire.

2. The attack should be made if possible on a course cutting the enemy's course at right angles. Therefore the boats must come down from a position forward of the enemy's beam.

3. An attack in daytime, made by torpedo-boats on a ship or ships under way, having good speed and not confined to a certain course, is hardly to be contemplated, except in very exceptional cases.

4. To attack a vessel at night, free in its movements, it is better to use a spar-torpedo boat than it is to employ an automobile-torpedo boat.

5. For an attack, in either daytime or night-time, against a

squadron which attempts to force a passage, automobile-torpedo boats are greatly preferable to spar-torpedo boats.

6. Finally, these last seem to have an advantage over the former in *any mêlée* where an enemy's squadron is opposed by one of your own.

V.

Since every point on the coast can become a place of debarkation for an enemy's army, every town on the coast can be burnt and pillaged by the hostile fleet, or even by simple cruisers, it is necessary to distribute over several centres of action the different constituent naval elements for the defence of this coast. These comprise rams, floating batteries, corvettes, gun-vessels of different sizes, and the various classes of torpedo-steamers.

These forces, in connection with shore defences, must guard and protect those points from which our squadrons and cruisers can escape into the open sea, and to which they may retreat for asylum in case the enemy be too formidable.

These centres must be beyond the range of guns of greatest calibre, and should prevent, by their number and their distance inland, the enemy knowing what is going on.

Works carried on in sight of the enemy can sometimes be concealed, especially at night, from the beams of the search-light by screens of dense smoke—such work, for instance, as the emplacing of guns.

The defence of a coast comes within two categories—a stationary defence and a movable defence. The first comprises submarine mines, booms, fortifications of every kind, placed beforehand or extemporized on the coast ; the second relies

on the action, isolated or combined, of rams, floating batteries, gunboats, torpedo-vessels, etc., supported, according to circumstances, by armored ships, or even the seagoing squadrons, should circumstances so conspire as to render necessary this combination for war remaining in its own waters.

Unquestionably the best coast defence is a fleet of specially constructed armor-clads, capable of going to sea in any weather along a coast. Then each harbor should have its flotilla of torpedo-boats.

Coast batteries cannot alone prevent an armored squadron from forcing a passage into a harbor: they must supplement their guns with mines. Conversely, any mine that is not protected by a gun is harmless, as it can be raised and destroyed.

For this reason gun-vessels and gunboats, small steamers and large tugs, furnished with small rapid-firing guns and machine-guns, are especially useful for mine protection and for coastwise employment.

Non-seagoing armored vessels are, as a general thing, of more value than fixed forts for the protection of harbors.

The tactical qualities of the torpedo-boat must be as well known as those of the ship, since, operating from a shore base, torpedo-boats will generally attack as a flotilla: indeed, the torpedo-boat acting singly has no place in modern warfare. No success can be derived from its independent action, as the assailed ship will always be more than a match for each individual boat.

To render the attack as irresistible as possible the torpedo-vessels must possess the following qualities:

1. Great speed, so as to enable the boat to be in the field of fire as short a time as possible, and so diminish the risk of being destroyed.

2. Show as little surface as possible, so as to reduce to a minimum the size of the target for the enemy's guns.

3. Be divided into as many water-tight compartments as possible to prevent being easily sunk.

4. Have the vital parts as well protected as possible.

5. A possibility of using automobile torpedoes without reducing speed.

6. Protection for the crew against small-arm and machine-gun fire.

7. Noiseless engines, so as to put off discovery as long a time as possible, and so be enabled to approach the enemy.

8. Great handiness.

9. Armament with machine-guns, to permit it to fight a vessel of the same size interfering with its designs.

An attack on a ship by torpedo-boats should be made with the flotilla divided into two or three divisions; one of these should act as a reserve. This last should either dash at the ship when the other torpedo-boats are engaging those belonging to the ship, or it should follow the ship when she seeks to retreat. If the vessel must retreat through a channel, it would be good tactics to have her attacked at one or two points in her passage out; the first attack being intended to engage her torpedo-boats and not to destroy the ship.

Besides doing their legitimate work, torpedo-vessels will have to fight small adversaries barring their way. As we have before observed, they may be the enemy's torpedo-boats, but again they may be picket-launches, tugs, or even booms and other obstructions. These will have to be overcome by machine-gun fire, hand-grenades, spar-torpedoes, and necklaces, or mines of gun-cotton or other high explosive. For this

purpose torpedo-boats should be fitted with the necessary weapons, leading wires, and batteries.

VI.

Let us conclude with the words of one who has thought a great deal upon the subjects which are dealt with in this little book: "The history of all navies which have attained any importance in the world, from the most ancient times downwards, has shown that tactical efficiency and naval success went hand in hand, and that the absence of the former assuredly led to the want of the latter."

THE END.

Plate I

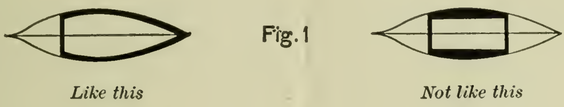


Fig. 1

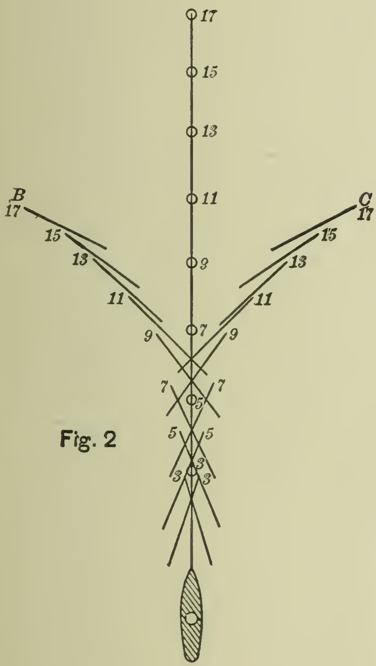


Fig. 2

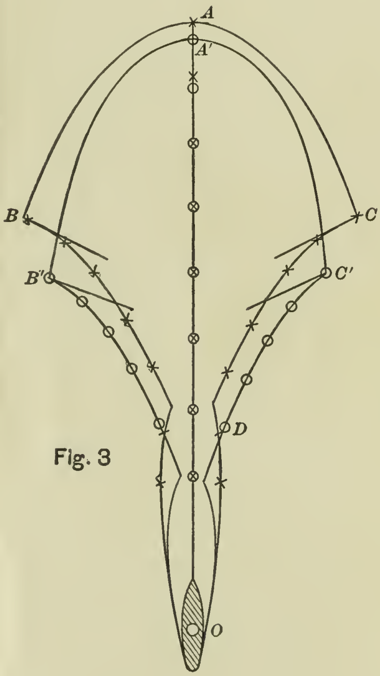
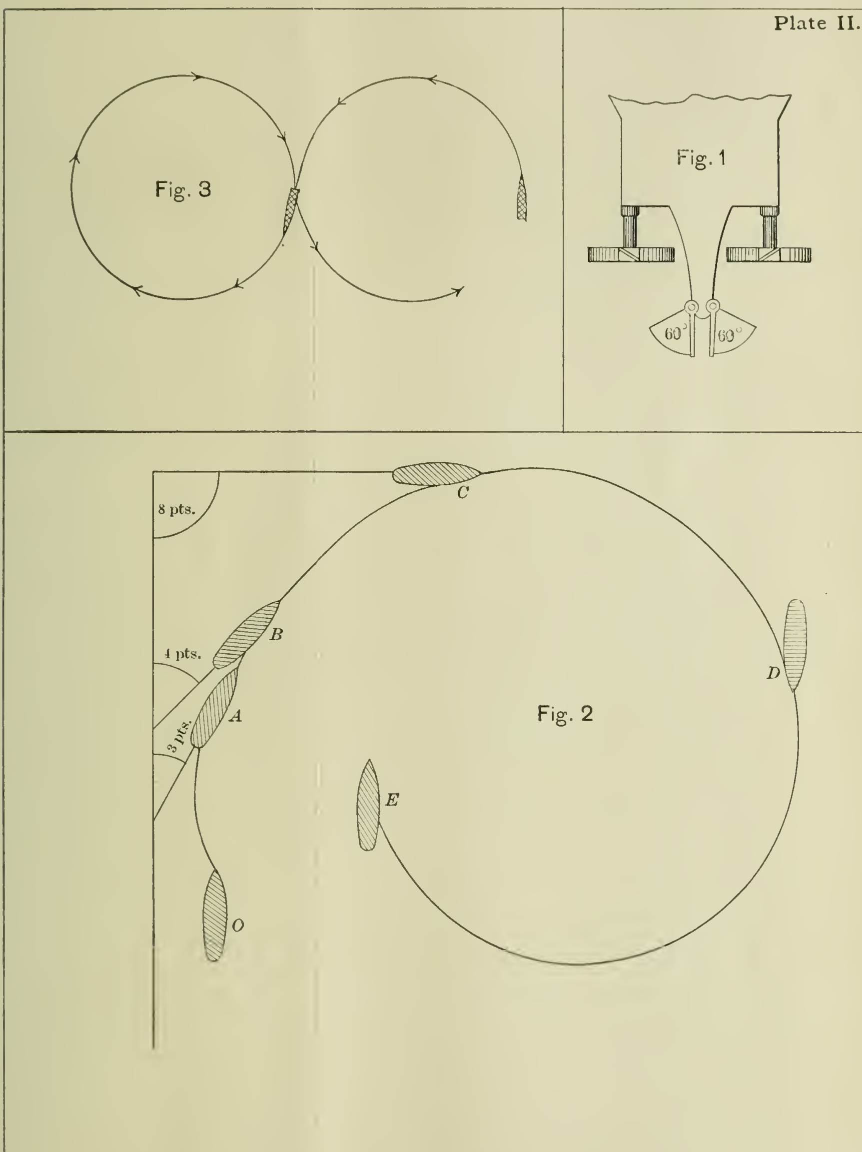


Fig. 3

Plate II.



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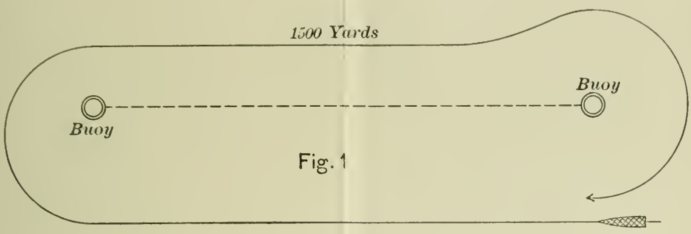


Fig. 1

Fig. 3

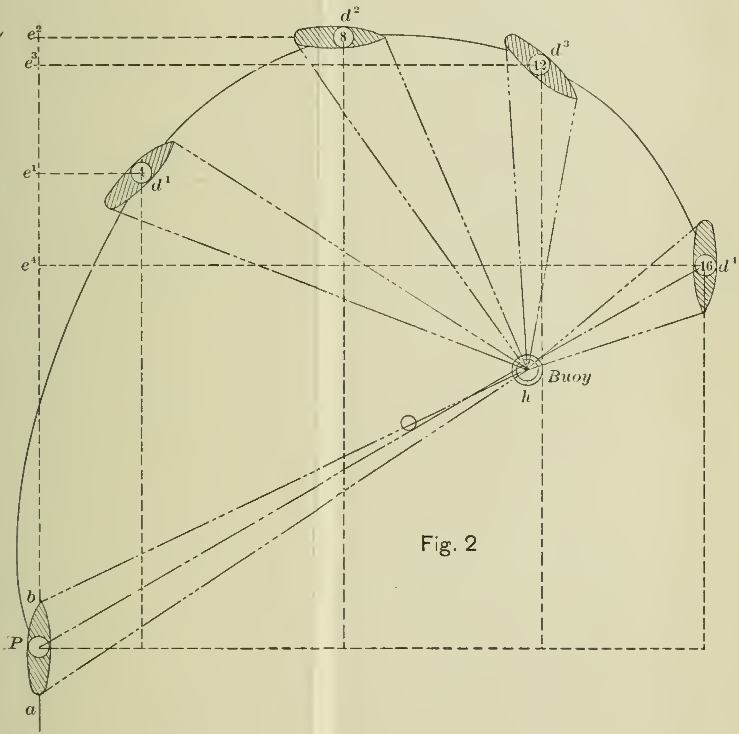


Fig. 2

Plate IV.

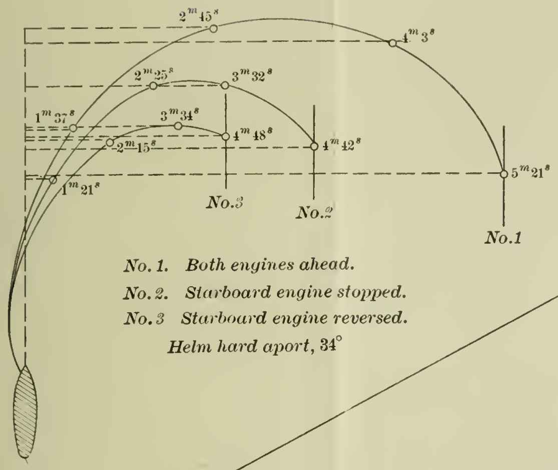


Fig. 1

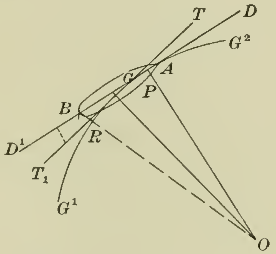


Fig. 2

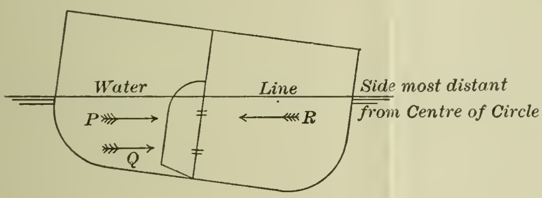


Fig. 3

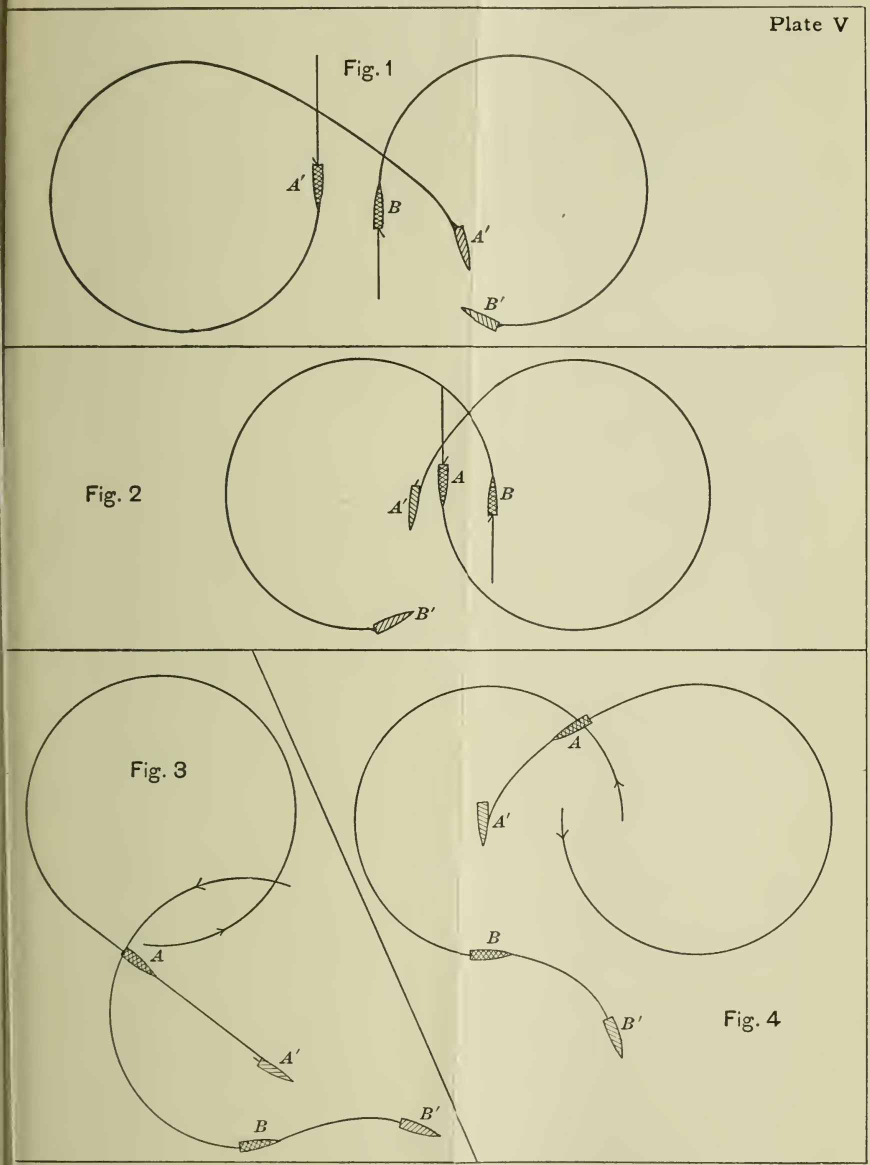
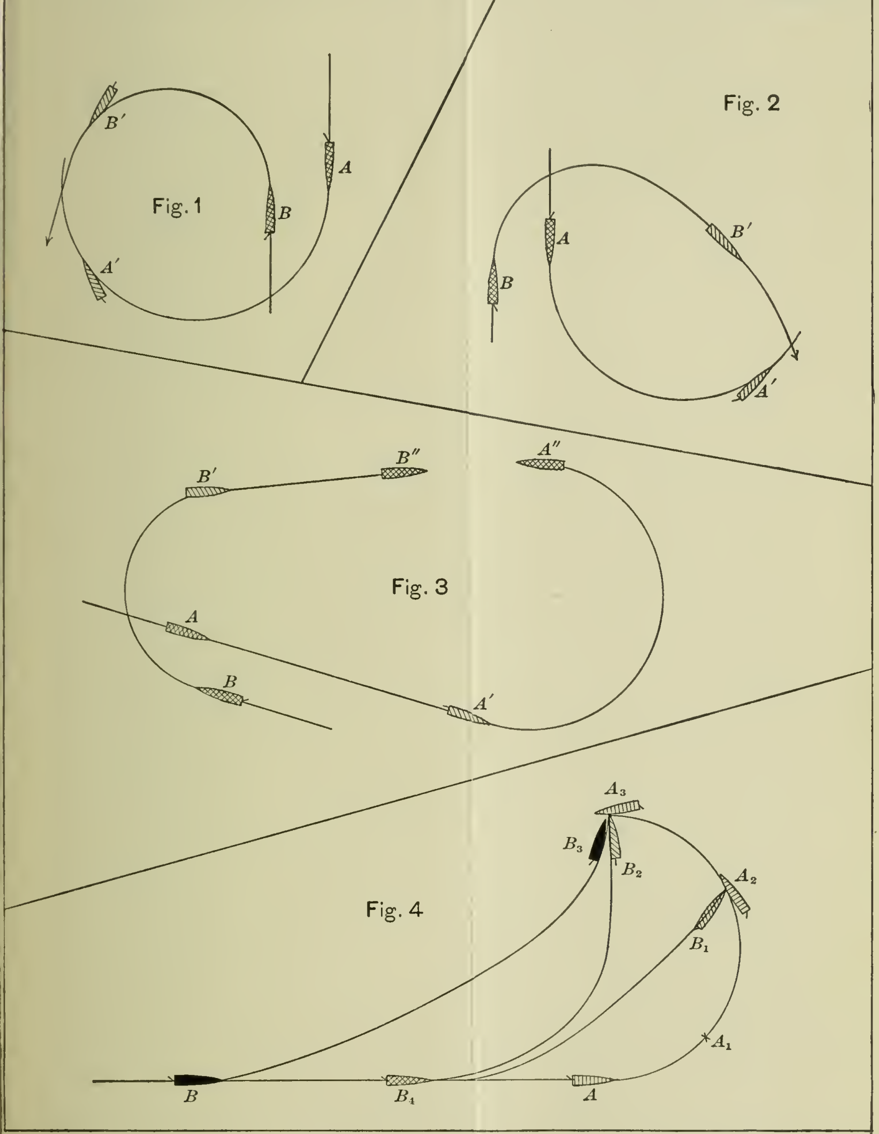


Plate V
Fig. 1
A′
B
A′
B′
Fig. 2
A
A′
B
B′
Fig. 3
A
A′
B
B′
A
A′
B
B′
Fig. 4

Plate VI.



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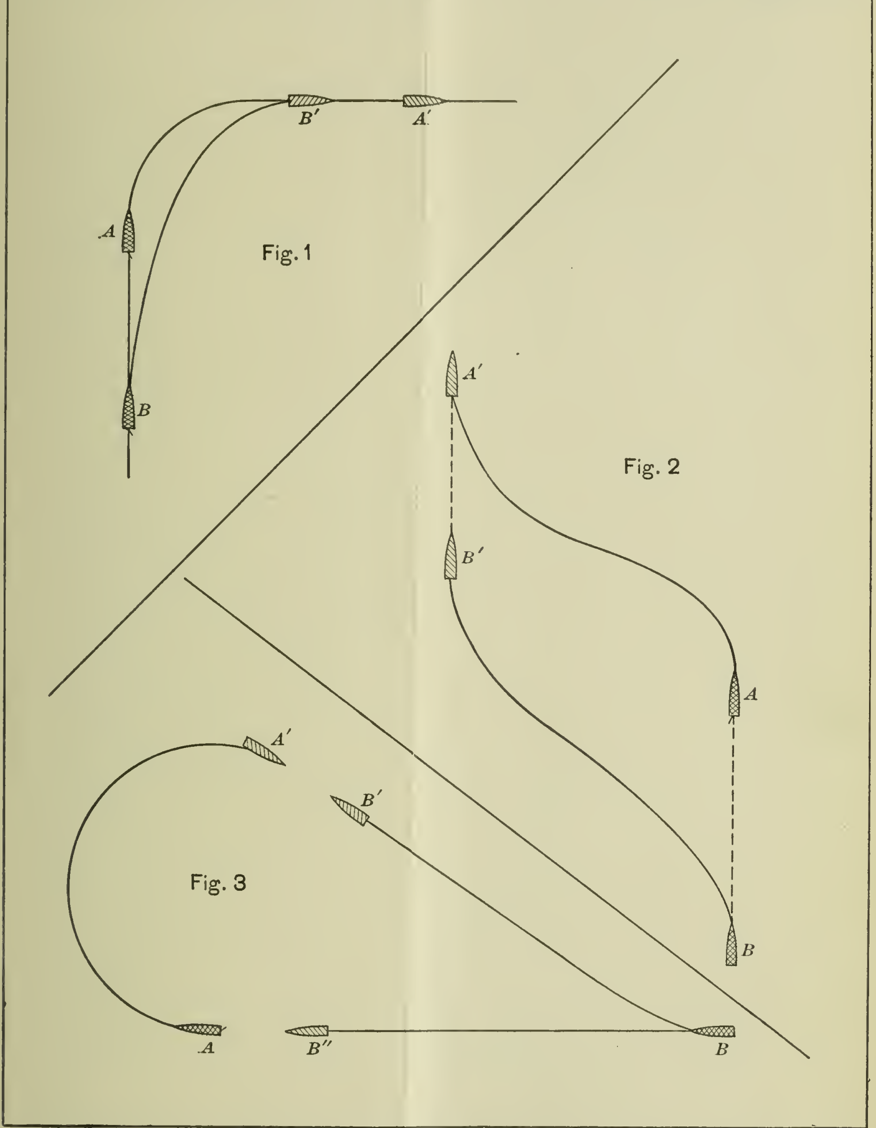

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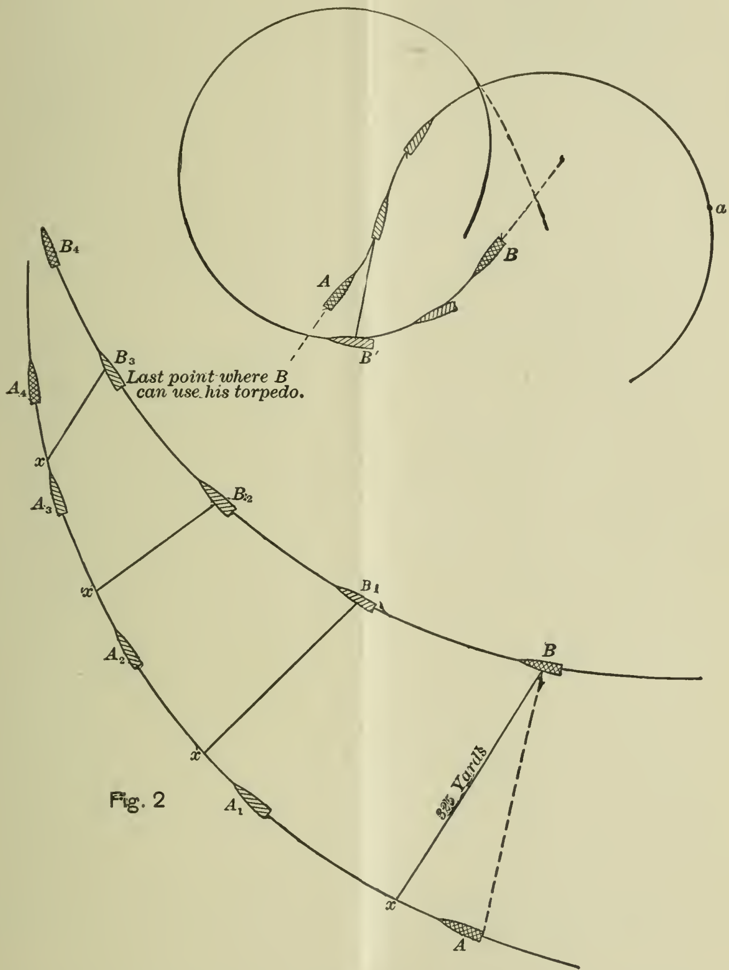


Fig. 2

Plate IX

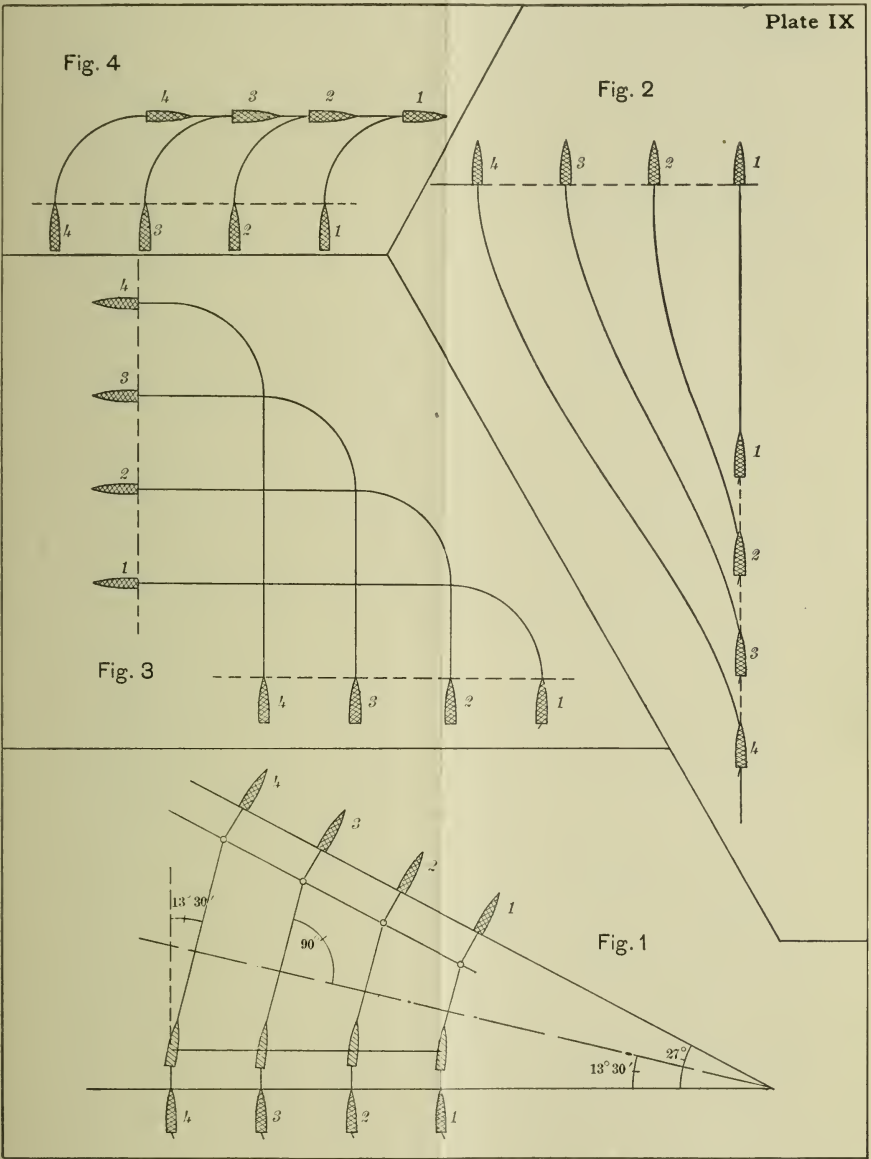


Plate X

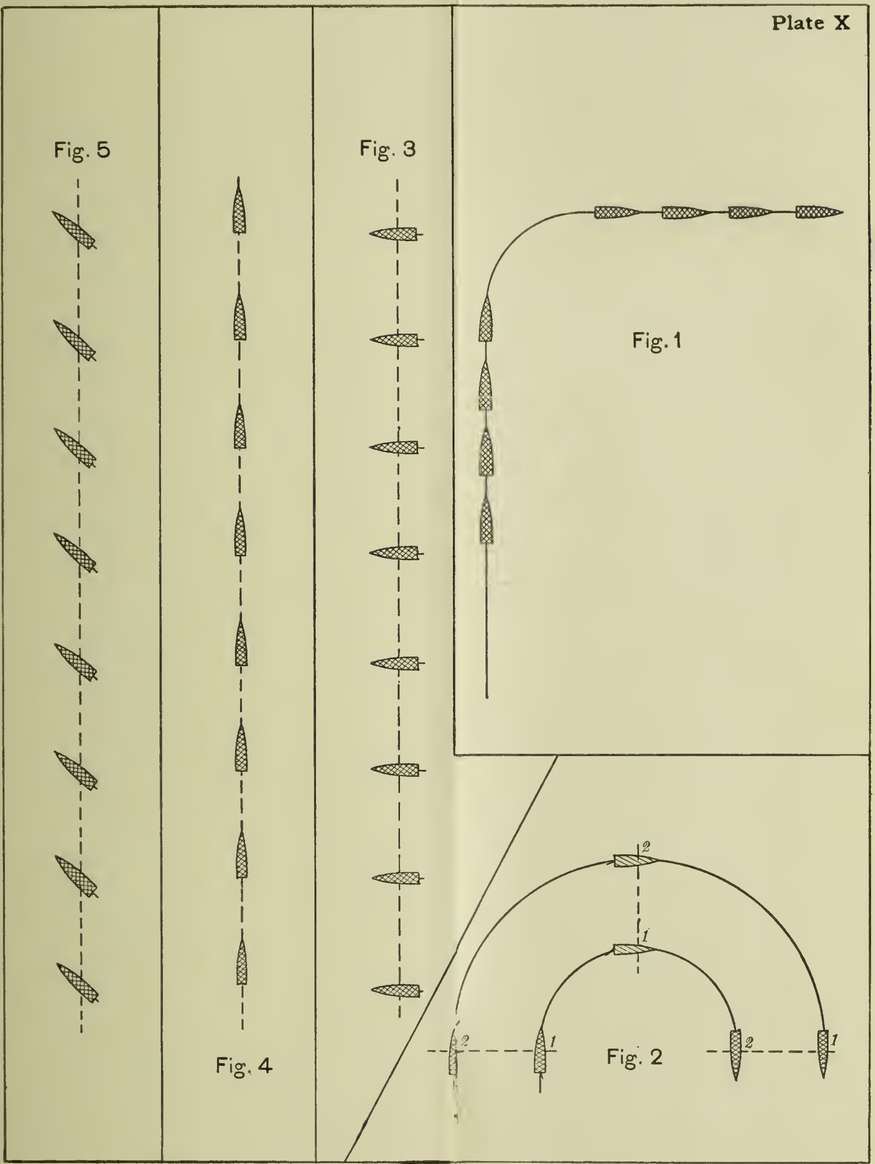


Plate XI

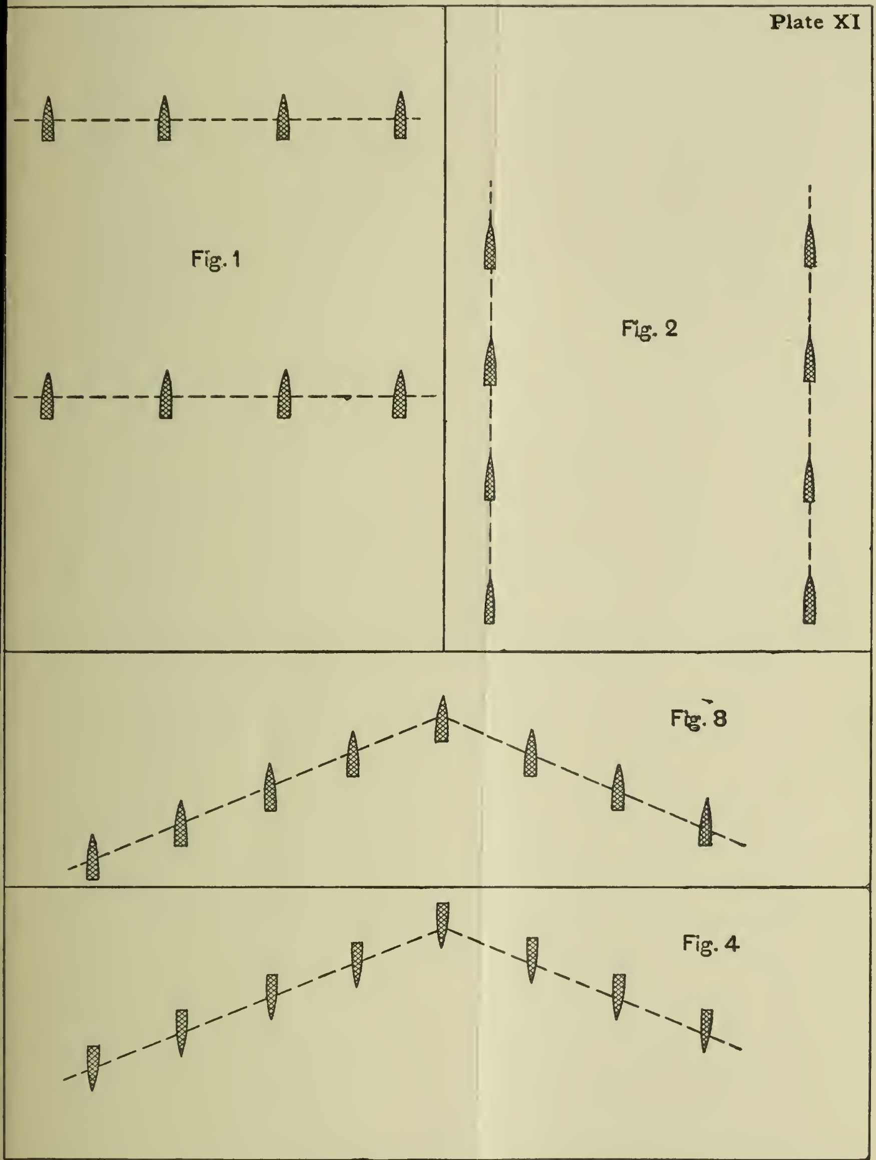
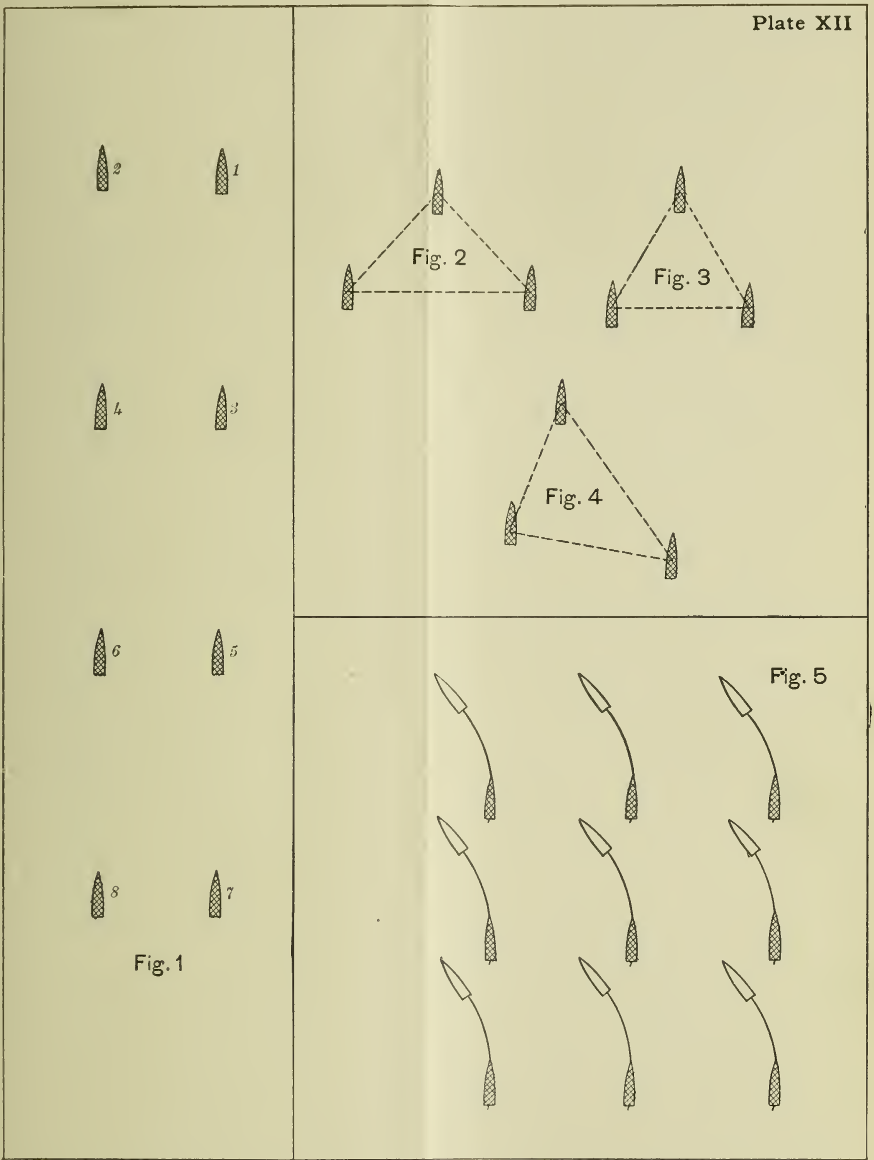


Plate XII



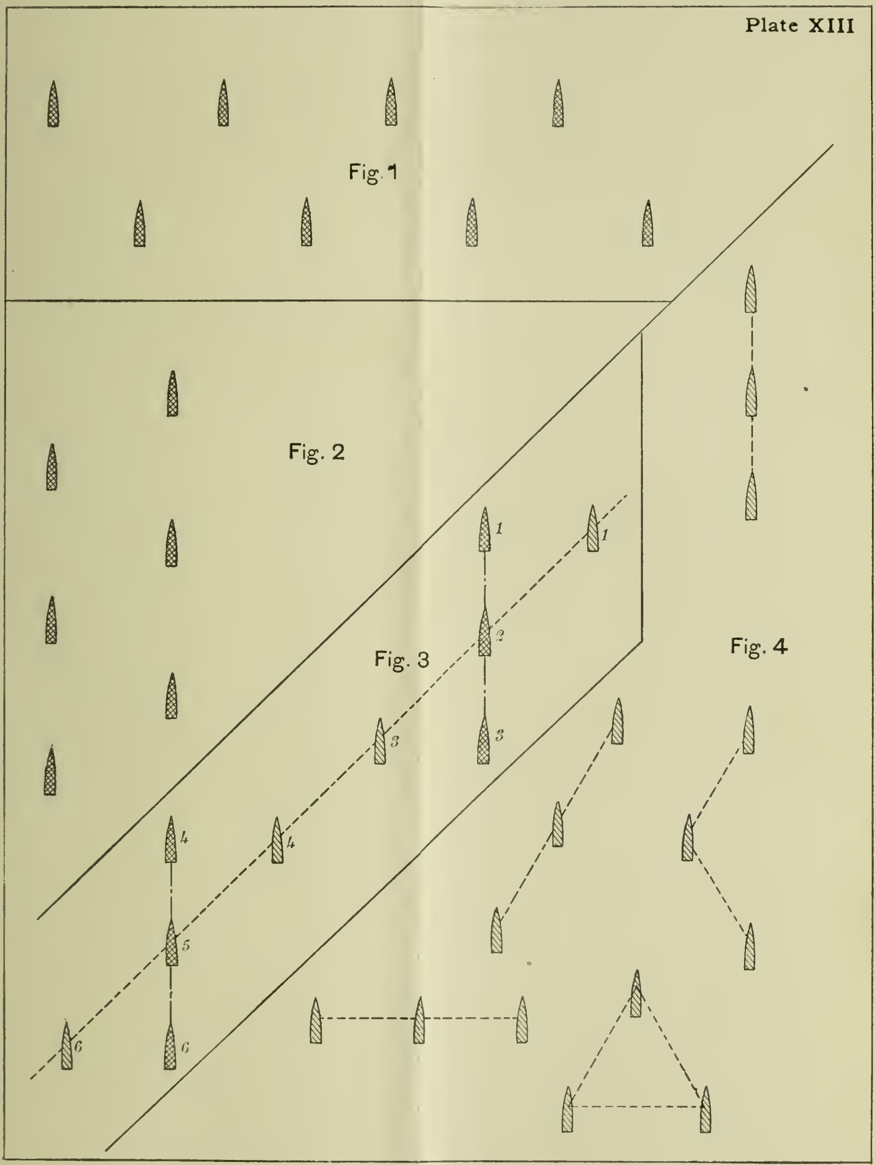


Plate XIII
Fig. 1
Fig. 2
Fig. 3
Fig. 4
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Plate XIV.

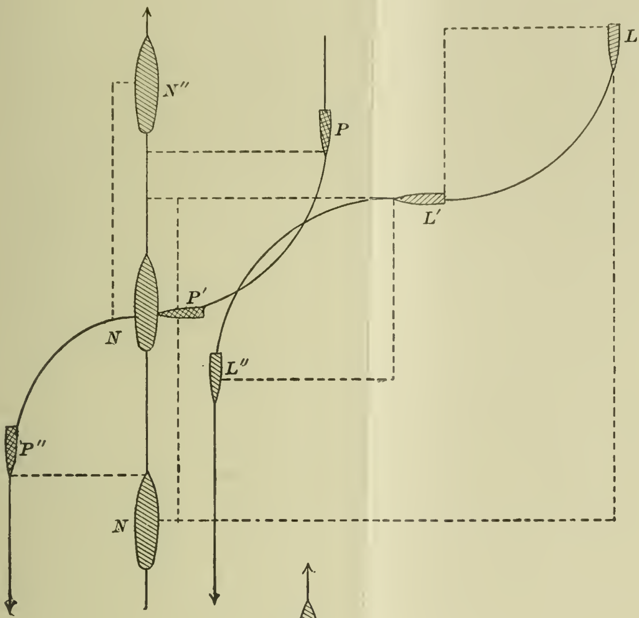

Fig.2

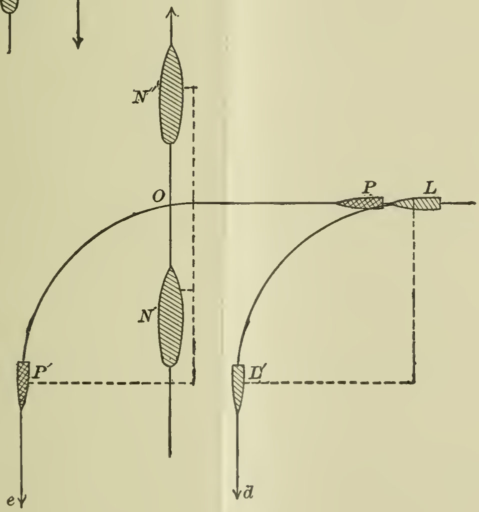

Fig.1

Plate XV.

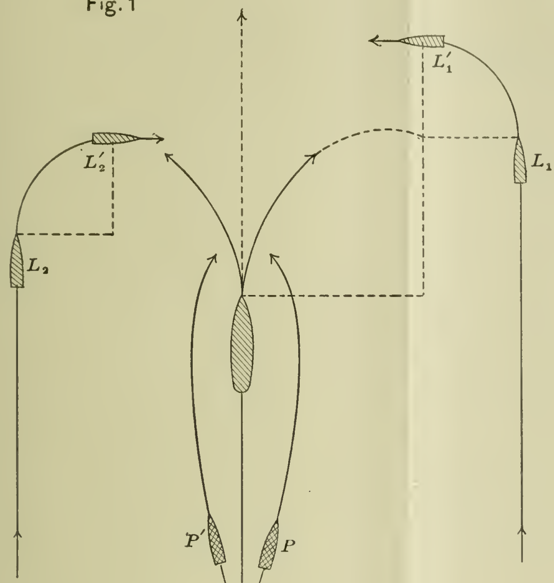

Fig. 1

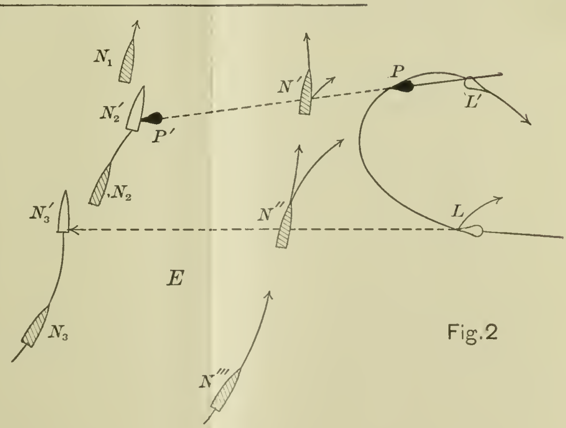

Fig. 2

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